

ROYAL COMMISSION
ON
AGRICULTURE IN INDIA

INTRODUCTION
TO
VOLUME VIII

EVIDENCE
TAKEN IN
PUNJAB



BOMBAY
- PRINTED AT THE GOVERNMENT CENTRAL PRESS
1929

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THE PUNJAB.

1. GENERAL FEATURES.

The Punjab, with a total area of 65 million acres, is a country just twice the size of England and greater by 9 million acres than the whole of Britain. About 3 million acres are occupied by the territories of certain Indian States* while 62,260,000 acres are under direct British administration. The northern portions of the province are mountainous and provide little culturable land, and even in the great plains there is still much land which, for want of water or other causes, is not under cultivation. At the present time the total area cultivated—an area growing rapidly as irrigation extends—is about 30 million acres. It is estimated that a further 15 million acres are culturable. Thus in time there will be available for the Punjab peasant a possession equal in extent to the whole cultivated surface of the British Isles.

The rainfall in the mountains is often torrential, in the sub-montane tracts it is sufficient, being usually from 30 to 40 inches, but throughout the plains it is scanty and uncertain, increasing gradually, as one traverses the province, from less than 5 inches in the south-west to 30 inches in the north-east; a fall of 10-12 inches may be expected at Lyallpur, 18-20 inches at Lahore and at Hissar, in the south-east, 11-13 inches. Readers of gazetteers not sixty years old will find the greater part of the Punjab plains described as being sandy deserts. But in the interval irrigation engineers have been at work and the deserts have largely been converted into fertile territory occupied by extensive cotton fields in the autumn, and by still more extensive wheat fields in the spring. Water is still, however, the paramount consideration to the Punjab cultivator. Too little of it, or occasionally too much, is at the bottom of most of his perplexities; his grievances centre round the short-comings, real or supposed, of the men who control the canals, just as the grievances of the British farmer usually originate from the failings of the clerk of the weather; but on the whole the unbiased observer must agree that, at least in the canal colonies, the Punjabi cultivator is the better served of the two; he can plan his tillage operations, sow his seed, and reap his harvest with a degree of certainty that many a British farmer would envy. Nor is the temperature, if hard on man and beast, unkind to the crops. There is rarely, as there was in the winter of 1926-27, a killing frost. Cotton gives rise to anxiety in cold winters, but only in the case of certain varieties, sugarcane can be grown even in the northern portion of the Province and is seldom a failure, and

* Until 1920-21 the area of Indian States included in the province was 24,600,000 acres. Most of these States have been brought into direct political relationship with the Government of India.

robacco is more certain of a safe season than the early potato crop of Britain. In the colder months the temperature of the plains may range from 35 to 45 degrees, and the growth of cereals is slow; but this gives them time to root and tiller before the forcing weather of the springs sets in, and they are seldom far enough advanced to be laid badly (as British crops are in July) by the occasional rain-storms of early spring. In the summer months, when the mean maximum temperature may rise to 110 degrees or even more in the shade, growth is extraordinarily rapid, and if weeds do grow apace on badly tilled land, the careful husbandman has his opportunities. He may then grow not only the main staples, but minor crops in a variety, and catch crops to an extent, impossible in a temperate climate.

The soils of the plains consist for the most part of a very deep alluvium, of light to medium texture; when dry they often appear to consist wholly of sand, but mixed with the sand of the surface soil there is always a proportion, often a very large proportion, of fine silt, naturally rich in plant-food, and under irrigation capable, even without manure, of producing for a long period crops that could not be equalled on unmanured land in Britain.

For successful cultivation in the plains water is the one thing needful, and this, as will be shown later, has been and is being supplied to new tracts at a rate which it is difficult for those who have no experience of large irrigation works to realise. The Punjab Administration Report for 1924-25 contains a graph showing that the area watered by Punjab canals rose from about 2 million acres in 1887-88 to over 11 million acres in 1922-23, and it is pointed out that the area irrigated by canals is now greater than all the ploughed land of England and Wales. It may be added that in five years' time it is likely to equal the whole arable area of Britain. It is, indeed, difficult to convey by mere figures the effect which these canals have produced on Punjab agriculture; the very term "canal" belittles them to those who are familiar only with British canals. The canals of the Punjab may perhaps be described as great "inverted" rivers. One of the largest, the Upper Chenab, may, without exaggeration, be described as an artificial Thames; for its upper reaches carry as much water as passes under London Bridge when the Thames is flooded, and its water passing into its "tributary" Lower Bari Doab Canal, fertilises the fields of cultivators as far distant from the head works as is the source of the Thames from its mouth.

The relative importance of the chief crops of the Punjab is shown by the diagram at the end of this introduction. It will be noted that wheat, gram *bajra* and fodder are the crops which occupy most land. The crops sown in 1925-26 and the current fallows account for nearly 34 million acres of cultivated land, and as the actual area under cultivation is about 30 million acres, it will be seen that some 8½ million acres of crops resulted from double-cropping favourably situated fields. The

normal rate of crop failure is 21 per cent. It goes as high as 65 per cent. in dry areas in poor years.

For the harvest of 1925-26 the Department of Agriculture has prepared some estimates which illustrate the scale of Punjab agriculture. The aggregate value of the chief Punjab field crops in that year was estimated at about Rs.100 crores (approximately £75 millions). Over one-third of this total was attributable to the wheat crop, of which 9.5 million acres had been sown. The resulting crop was estimated at 2.9 million tons of wheat. The magnitude of the Punjab wheat crop is emphasised if we recall the fact that it equals about half the annual import of wheat into Britain, and that (if we exclude the grasses and clovers grown by him) it covers nearly as much land as the British farmer has at his disposal for the growing of all his other crops. Next in importance to wheat in point of value is the cotton crop, which, in 1925-26, was worth nearly Rs.15 crores.* The next crop in order of value was gram (Rs. 8.6 crores). Of lower relative value, but of great intrinsic importance, were raw sugar 6.0, rice 4.6, maize and *bajra* 3.8 each, oil-seeds 3.2, and barley 2.1 crores.

A periodical census of livestock is taken. In the last four of these cattle have shown no tendency to increase; the figures were: 1908, 14.2 millions; 1914, 15.5 millions; 1920, 14.3 millions and 1923, 14.9 millions. In the last census year there were 4.1 million bullocks (including bulls), 2.7 million cows, 3.0 million buffaloes, and 5.1 million young stock, including young buffaloes. These figures are open to question, and the Agricultural Department estimates the approximate numbers to have been 4.5, 3.0, 3.4 and 4.0 million respectively. There is no doubt that the actual number of cattle, both for draught and dairy purposes, is sufficient, but the quality, especially the quality of milking cows, leaves much to be desired, and in urban centres the supplies of milk and *ghi* available are limited, and the prices high.

The numbers of sheep and goats in 1923 were 4.1 and 4.3 million respectively, and there were 390,000 horses, 650,000 donkeys and mules, and 260,000 camels. Sheep are important in the arid tracts of the province, while goats are widely distributed. The breeding of army remounts and transport mules is a considerable industry in a few districts. Camels are found mainly in the dry, sandy areas.

2. NATURAL DIVISIONS.

From the point of view of agriculture, five fairly well-marked divisions may be distinguished in the Punjab. A brief reference to the characteristics of each will be desirable.

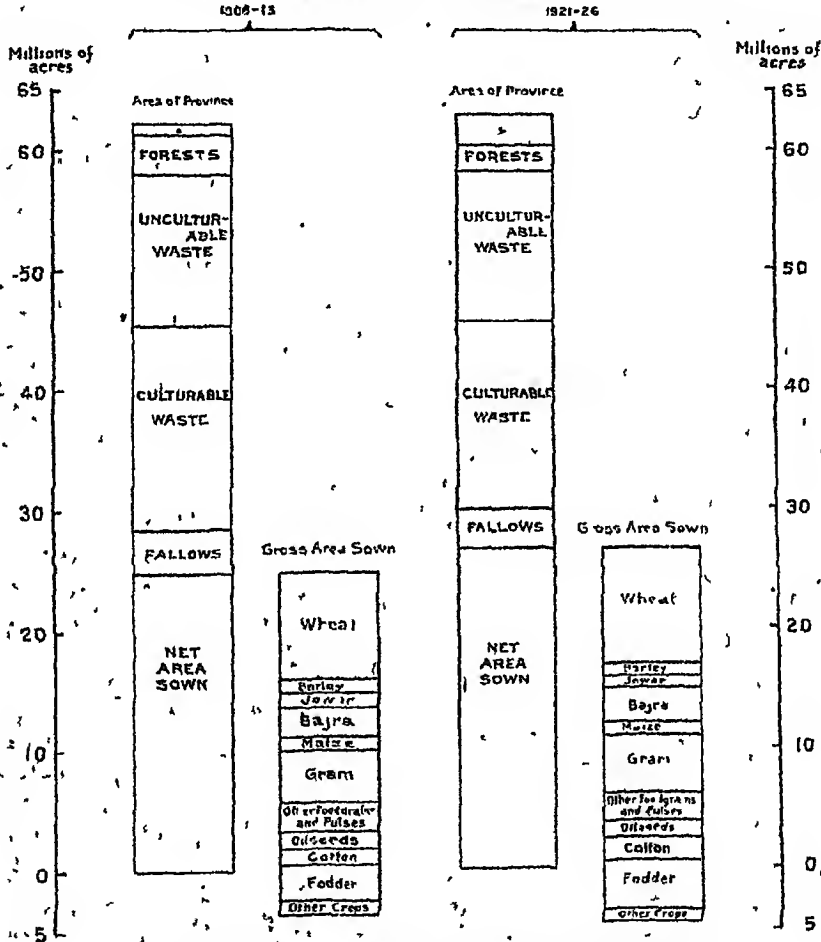
Central Division.—This division, which stretches from Gujrat in the north to Muzaffargarh, Multan and Ferozepore in the

* In 1924-5, a very favourable year for cotton, it was worth nearly Rs. 20 crores.

PUNJAB

CLASSIFICATION OF TOTAL AREA AND AREA UNDER VARIOUS CROPS (5 Year Averages)

Note. The difference between the Gross Area Sown & the Net Area Sown represents the area sown more than once



* The areas marked with an asterisk represent the difference between total area of the province according to the Professional Survey and the total area according to the Village Reports, the latter being the source from which this diagram was constructed;

south, is much the most important agricultural part of Punjab. It is bounded in part by the Jhelum on the west, and is traversed by the rivers Chenab, Ravi, Beas and Sutlej. It consists of level plains with narrow strips of low-lying land bordering the rivers. Until about thirty years ago, the western (Canal Colony) region of these extensive level plains was almost valueless owing to the rainfall being insufficient to mature crops; but almost the whole area has now been commanded by canals most of which are perennial. The cultivators in this tract consist in part of those already settled along the river valleys before canals were constructed, and in part of colonists introduced from congested districts of the Punjab. The latter have been settled on "squares" or "rectangles" of land of from 25 to 27½ acres, and new, carefully-planned, villages have been built. The compact, well-arranged fields enable cultivators to work their holdings economically and the general level of cultivation in the canal colonies is high. The leading crops are wheat, gram, Punjab-American cotton, rape, and mustard.

Western Division.—To the north-west and west of the central irrigated area, and composed of the districts of Jhelum, Rawalpindi and Attock, with parts of the districts of Shahpur, Mianwali and Dera Ghazi Khan, is a dry area not open to irrigation from canals and irrigated only to a small extent from wells. Agriculture is, therefore, dependent on rainfall, which in the north of this area is usually sufficient to mature a crop, but in the west and south is uncertain and deficient. Here and there in river valleys good cultivation is found, as in the Chhach circle of Attock, where valuable crops of sugarcane and tobacco are grown under well irrigation; but for the most part the riverain tracts produce indifferent wheat and gram crops in winter, and small quantities of fodder in summer. The people are almost entirely Muslim, of fine physique. Cattle and horse-breeding help to supplement the meagre yield of the crops. This division forms a notable recruiting ground for the army; thus income from the land is assisted by the pay and pensions of soldiers.

Mountainous Region.—Along the northern boundary lies the western portion of the great Himalayan chain. The north of Gurdaspur district and the whole of Simla are embraced in its spurs, while, in between, the district of Kangra lies right athwart the range, two of its cantons being in trans-Himalayan country. The rainfall is abundant, but the soil is rocky and the surface often precipitous, so that much labour is involved in terracing and preparing land for cultivation. Rice is cultivated with the aid of irrigation from watercourses led out of mountain streams; on unirrigated land wheat, barley, maize, pulses, buckwheat and amaranth are grown as food crops, and sheep-breeding supplements the earnings of the people. As in the case of the Western Division, many young men join the army. The pressure of population on the land is

great, and the problem of improving the output of these over-peopled mountain soils is as important as it is difficult.

Submontane and Eastern Division.—Between the Central Division and the mountainous region referred to above, there lies a submontane tract with a rainfall of from 35-40 inches, and a wide stretch of flat country with a rainfall of from 15 to 20 inches. The administrative districts included in this division are Sialkot, Gurdaspur, Hoshiarpur, Jullundur and Ambala, with parts of Ludhiana, Karnal, Rohtak and Hissar. With the exception of Jullundur and Hoshiarpur, all these districts receive irrigation from the great canal system, but the Western Jumna can only protect a part of the three south-eastern districts of Karnal, Rohtak and Hissar, leaving the great portion of the land dependent upon a very capricious rainfall. In the whole tract, well-irrigation is an important feature. In areas where the water table is within 20 to 40 feet of the surface and where the texture of the soil is light and suitable for intensive cropping, the cultivation is of very high quality.

In the submontane tracts wheat, and even sugarcane, can be grown without irrigation. The country is naturally rich, but the climate during the monsoon period is unhealthy. Much fertile soil has been lost in recent times in parts of the Hoshiarpur and Ambala districts because of erosion following the destruction of hillside forests. A special Act (Act No. II of 1900, as amended by Act No. IV of 1905, Act No. VII of 1926 and Act No. VIII of 1926) has been passed to prevent further damage, and efforts are being made to enlist the sympathy and aid of the people in restoring trees on the devastated slopes.

South-Eastern Division.—This dry region includes those parts of the districts of Hissar, Karnal and Rohtak not watered by the Western Jumna Canal, and Gurgaon. Although the rainfall is usually somewhat greater than in the Western Division, this region suffers much from drought. In some parts well irrigation is possible, but in others the water table is so deep that raising water is too expensive. Some assistance to the natural rainfall has been given by constructing dams, but much remains to be done before the requirements of crops are met. Crop-growing being so uncertain, special attention has been given to cattle-breeding, and this tract is the home of the celebrated Haryana breed.

3. PROVINCIAL INCOME AND EXPENDITURE.

In order that the activities of the Punjab in developing its resources may be traced in proper perspective, it will be necessary to glance at the financial position. In certain other provinces there was much evidence to the effect that lack of money was the root of all evil. This was not the case in the Punjab, although in picturesque terms it was pointed out to the Commission that there were times within the past five years when the

GOVERNMENT OF THE PUNJAB.
Revenue and Expenditure Charged to Revenue.
(Figures are in lakhs of Rupees.)

Revenue Head.	1921- 22.	1922- 23.	1923- 24.	1924- 25.	1925- 26.	Expenditure Head.	1921- 22.	1922- 23.	1923- 24.	1924- 25.	1925- 26.
<i>Principal Heads of Revenue—</i>						<i>Direct Demands on the Revenue—</i>					
Land Revenue	221	298½	299	291	306	Land Revenue	49	45½	41½	42	44
Excise	116	103	104	119	128	Forests	44	49½	29½	27	26½
Stamps	82	89	96	116½	114½	Other heads	8	7½	7	8	21½
Forests	50	34	41	37	41	Capital outlay on Forests charged to Revenue.	—	—	—	—	2
Other Principal Heads...	6	121	11	11	13	Irrigation—Revenue Account ...	92½	89½	102½	109	115½
Irrigation : Net Receipts...	333	364	392	130	457	Irrigation—Capital Account charged to Revenue.	0½	—	—	—	81
Debt : Interest	4	6½	5	6	12	Debt Services—Interest on Ordinary Debt.	—4	2½	*6½	—1	—6
Civil Administration	31½	37	41½	41	41	Debt Services—Reduction or avoidance of Debt.	—	—	—	2	2
Civil Works	4	4	5	5	6	<i>Civil Administration—</i>					
Miscellaneous	17	25	24	25	23	General Administration	97	101	100½	99	104
Miscellaneous adjustments between Central and Provincial Governments.	—	—	—	1	0½	Administration of Justice	41½	45½	53	54	52½
Extraordinary Receipts (Sale of Waste Lands, Government Estates, Town Sites, etc.)	33	30	69½	68	129	Jails and Convict Settlements ...	36	38½	29½	30½	32½
						Police	111½	122½	110	112	107½
						Education	88½	99½	103½	109	142
						Medical	32	30½	31	30½	35½
						Public Health	11	11	11	15	16
						Agriculture	32	30½	28	28½	38
						Industries	6	8½	8½	7	7½
						Other Departments	1	2	2½	3	1
						Civil Works	124½	105	84½	70	109
						Miscellaneous	107	96½	55	49	62½
						Provincial Contribution to Central Government.	175	175	175	175	114
						Miscellaneous adjustments between Central and Provincial Governments.	13	0½	—	1	—
Total Revenue	897½	1003½	1091	1153½	1266	Total Expenditure charged to Revenue	1089	1061	979	972½	1108½

Capital Receipts and Expenditure.

Receipt Heads.	1921- 22.	1922- 23.	1922- 21.	1921- 25.	1925- 26.	Expenditure Heads.	1921- 22.	1922- 23.	1923- 24.	1924- 25.	1925- 26.
Revenue Surplus	—	—	112	183	157½	Revenue Deficit	171½	57½	—	—	—
Loans and Advances	13½	12½	21	18	15	Construction of Irrigation Works	19	91	146½	83	82½
Permanent Debt incurred	—	—	192	—	73½	Civil Works	—	2	1½	20	19
Loans from Central Government	100½	60	—	—	—	Loan from Central Government (repaid).	—	—	100½	—	1
(for Revenue).	—	72	—	—	—	Loans and Advances	63½	23	14	30	18
Loans from Central Government (for Irrigation).	—	4	1	3	3	Payment to Central Government of Balance of Provincial Loan Account.	53	—	—	—	—
Famine Insurance Fund	—	—	—	2	2	Other Capital Expenditure	—	1	1½	4	3½
Reserve and Sinking Fund	—	—	—	—	—						
Total Capital Receipts	111	178½	329	206	251	Total Capital Expenditure	307	174½	261	137	121
Opening Balance	193	—	4	72	141	Closing Balance	—	4	72	141	268

wastepaper baskets of departments were being ransacked in the hope of converting the contents, if not into rupees, at least into annas and pies! Although great capital commitments have been, and are being, incurred on irrigation and other public works, a substantial proportion of the investments rapidly become remunerative; and difficulties, when they have arisen, have more often been of the kind experienced in a rapidly expanding business, than of the kind which embarrass the chancellors of debt-encumbered nations. In 1921-22 the Government had on its loan account an overdraft of about a crore from the Government of India. This has been paid off; and the capital since required, with the exception of $1\frac{1}{2}$ crores raised by loan at $6\frac{1}{2}$ per cent, has been provided from ordinary revenue or extraordinary receipts. But it is not now intended—for this is not the time or place—to discuss the financial situation and financial outlook of the province. All that is here required is to state what the recent income and expenditure have been and to show the main headings under which receipts accumulated and disbursements have been made.

4. REVENUE ADMINISTRATION AND LAND RECORDS.

Benefiting by the experience of the older provinces the Government of the Punjab from the beginning devoted careful attention to local facts and customs in devising a system of administration of land revenue and tenure.

For the purpose of revenue management the whole province is divided into five divisions, each under a commissioner, not identical with, but roughly corresponding to, the natural divisions above described. The divisions are further divided into twenty-nine districts, each in charge of a deputy commissioner. The districts are sub-divided into three or four tahsils each in charge of a tahsildar and an assistant or naib-tahsildar.

The unit of revenue administration is an estate, usually identical with a village, of which there may be on an average from 200 to 400 in each tahsil. In each village there are one or more headmen or *tambardars* who represent the villagers in their dealings in revenue matters with government officials; the headman is a paid representative, getting five per cent of the revenue collected from the village. Originally the villages were treated as communities jointly responsible for the total amount of revenue due, and legally this obligation remains; but in practice in the canal colonies the revenue is now collected from the individual who is the owner or grantee of land registered as his holding in the village records. Much attention is given to village records. the whole of the land is carefully mapped on a scale of 220 feet to the inch, and a village register of rights of ownership, and tenancy, is maintained by a minor revenue official, the *palwari*, who has charge of the books of one or more villages. The villages are grouped into circles or *zails*, and in each circle

a leading *lambardar* is recognised as *zaildar*, or representative of the people, and as such he receives payment for his services. To supervise the work of *patwaris* a *ganungo* or inspector is appointed. A *ganungo* usually supervises proceedings in some twenty circles. Close inspection is necessary, for much detailed work is required of the village *putwari*. His village note-book summarises the revenue records in statistical form and so constitutes the basis of all agricultural statistics. The different revenue records show: the area of each holding; the *kharif* and *rabi* crops grown; the position as regards revenue payable, or paid; the transfers of land, whether of ownership or of occupancy rights; a list of owners and of mortgages or revenue assignments effected by them; statements of the rent paid by tenants-at-will; and a record of the livestock, and of certain kinds of dead stock, in the possession of the cultivators. Special importance is attached to the Record of Rights. Under the Punjab Land Revenue Act, 1887, which is the basis of all revenue administration in the province, a record must be maintained for every estate, showing all the fields into which the estate is divided, the names of the persons who are owners or tenants, and the nature of their interest in the land. This record must be brought up to date and re-written every four years, and, at intervals of twenty or thirty years, when the assessment to land revenue is re-settled, a special revision of the village records is made.

The re-settlement of a district is a lengthy process conducted by a special settlement officer, under the supervision of the commissioner of the division and the Financial Commissioner of the province. The district is in the first place divided into assessment circles in which the agricultural conditions are similar, and then a careful estimate is made of the net rents, or assets for each circle. These estimates take into account cash rents in the relatively few cases in which cash rents are paid. When rent is paid in kind the produce of land, customary payments to village menials and other consequential charges are ascertained, and the revenue is based on the estimated net income derived from ownership of land. In pre-British times the rulers of the Punjab collected produce rents, varying with the times and with the ruler's conception of his rights and his needs, but always high. Originally the maximum cash demand made by British collectors was limited to 50 per cent of the net assets; but as in practice this figure was never reached, and is now being reduced to 33½ per cent, the usual revenue demand is about 25 per cent of the estimated net assets. In addition to the land revenue, villagers have to pay a local rate imposed by district boards on all land assessed to land revenue, which varies from district to district, and is limited by statute to an amount not exceeding twelve and not less than ten pies for every rupee of its annual value.* There are also certain village cesses.

* The Punjab District Boards Act, 1883, as modified up to 8th May, 1925.

The total amount of land revenue collected in the year ending 30th September, 1924, was 443 lakhs of rupees, of which 243 lakhs was permanent and 200 lakhs fluctuating revenue. The collection of fluctuating revenue is a feature in the Punjab administration. It originated because of the great uncertainty of the harvests in the dry tracts. With the object of reducing suspensions and remissions of revenue, the plan of charging revenue on the land from which crops were actually harvested was introduced. It was subsequently found that this method of collection was also specially suited to the conditions in canal colonies, where the charges made for canal water had always been based on the actual crop grown and the area under that crop. Remission of this fluctuating revenue is never necessary, though suspension is sometimes called for in the event of unforeseen calamities. In a province where the rainfall is so small two main factors govern the actual amount of land revenue payable. If no means of irrigation exist, soil and rainfall, by determining the net returns which the cultivator secures, determine also the general level at which revenue is levied. If from any source water can be secured which will ensure the ripening of a *kharif*, or a *rabi* crop, or of both, then, since net returns are increased, a higher rate of revenue is collected. Should the water come from a government canal, the cultivator pays, in addition to land revenue, a water rate varying in amount with the kind of crop grown, but in every case the rate charged for canal water is very much less than the cost to the cultivator of raising water from wells. Thus when canal water is brought into a district the wells which may exist there usually fall into disuse.

Just as the Land Revenue Act, with the rules and orders framed under it, regulate the relations between the landowner and the Government, the Punjab Tenancy Act regulates the relations between landlord and tenant. There are two chief kinds of tenants. The hereditary or occupancy tenant holding under old custom, usually paying a privileged rent, and not liable to disturbance so long as he carries out the conditions of his tenancy, and the tenant-at-will. The Act defines the circumstances under which occupancy rights accrue and the nature of these rights, and it protects the tenant-at-will so far as possible from hardship.

A third Act which has an important bearing on the position of the zamindar is the Punjab Land Alienation Act, 1900. Before the passing of the Act much land was being expropriated by moneylenders to whom the owners were indebted. Under the provisions of this Act the main agricultural tribes in each District are listed in groups. Within these groups the Act imposes no restrictions on alienation, members of the listed tribes may sell freely to persons within their own group, but not to others; for the Act allows of the sale of land to non-agriculturists only under special circumstances which must be

approved by the deputy commissioner. The Act has aroused keen controversy; but the criticism so far has come from non-agriculturists, and it is admitted that it has checked the evil which it was designed to cope with. It was at first feared that by affecting the value of land, the Act might injure the agriculturists' credit, but the records of land sales shows that this fear was groundless. There has been a very rapid rise in land values in the Punjab, and such is the land hunger that many sales are now effected at wholly uneconomic prices. For the four years preceding the Act of 1900, the arithmetic mean of the average price at which cultivated land sold in each year was Rs.81 per acre. In the following five-year periods up to 1924-25 the corresponding figures were Rs.77, Rs.105, Rs.158, Rs.231 and Rs.373. The average recorded price of cultivated land rose from Rs.383 per acre in 1923-24 to the record figure of Rs. 438 during 1924-25, and in the Lyallpur district it was as much as Rs.738. The sale price of land for the province as a whole represents 300 years purchase of the land revenue as against 273 in the previous year and 6 at the commencement of the British occupation. For a year or two after the Alienation of Land Act became law prices may have been affected; but the figures for subsequent years make it clear that the movement of land values in the Punjab now calls for a brake rather than a stimulus.

5. THE CULTIVATOR.

It is not possible in this brief introduction to rural conditions in the Punjab to give any adequate account of the many types to be found among the tribes differing in race, and the communities differing in religion, who till the soil of the Punjab. Nor fortunately is such required or necessary; for a Punjab civilian, Mr. M. L. Darling, has recently supplied in his book, *The Punjab Peasant in Prosperity and Debt*,* a description which has already taken its place among the now considerable number of classic monographs that relate to the peoples of India. A sketch of the cultivator, of his social and economic position, and of his special difficulties, has been supplied to the Commission in the memorandum prepared for them by the Punjab Government, and from this source, in itself largely dependent on Mr. Darling's book, a few facts may be given.

The Punjab Census of 1921 showed in British districts a total population of about 21 millions, of whom some 10 per cent lived in towns. The remainder lived in about 34,000 villages, with an average population of just under 500. Of the villagers, 100 would own land extending to about 1,140 acres, of which some 770 acres would be cultivated. The village is constructed from local materials, the flat-roofed houses are usually built of sun-baked mud, while here and there stand the more substantial brick houses of some *bania*, army pensioner, returned emigrant, or

* Oxford University Press, 1925.

retired official. The lay-out, except in the canal colony areas, is haphazard, the water-supply coming usually from a well, tank, or canal. Sanitation, in the sense of an ordered scheme for the disposal of offensive matter, in the words of the Public Health Department, "does not exist." Beyond and surrounding the village site are the scattered fields of the zamindar.* It is difficult to arrive at close estimates of the number of actual cultivators, and of the amount of land occupied by them in different districts, but the estimates usually accepted placed the number of actual landowners, including minors and women, at about four millions, and the number of adult cultivators at between 4½ and 5 millions. Recent economic enquiries based on sample areas suggest that these figures are too high. The samples were extensive, covering over 2,000 villages scattered throughout the province, and the figures obtained throw so much light on the position of the Punjab peasant cultivator that a few of them may be given here.

In the first place, the enquiries bring out the fact that in the Punjab there is no sharp differentiation between the owner, tenant and labouring classes. An owner of a few acres belonging to an agricultural tribe may hire land for cultivation, or he may supplement his income by working for wages; conversely a member of one of the menial tribes, who habitually works for wages, may own a small plot of land. The enquiries were primarily directed to ascertain the conditions of "owners" on the one hand, and of "cultivators", whether owners or tenants, on the other. The following statement† shows how the land in the sampled areas was distributed between groups of owners and of cultivators.

Group.	Percentage Owned.	Percentage Cultivated.
In holdings of under one acre ...	1.0	1.5
" " " 1 and under 5 acres	11.0	12.1
" " " 5 " " 10 "	15.1	20.6
" " " 10 " " 15 "	11.5	17.4
" " " 15 " " 20 "	8.4	12.3
" " " 20 " " 25 "	6.8	9.1
" " " 25 " " 50 "	20.4	18.5
" " " 50 and over ...	25.7	7.9

Taking the province as a whole, the "average" cultivated area belonging to an owner would, on the basis of these large samples, work out at about 8 acres, and the average holding under tillage in the occupation of each cultivator, whether owner or tenant, at 7 acres.

* The term zamindar, literally landowner, is in some provinces, as e.g., Bengal, applied only to large landowners; in the Punjab it is used for any landowner, however small.

† 1. "The Size and Distribution of Agricultural Holdings," by H. Calvert C.I.E., I.C.S., Board of Economic Enquiry, Punjab, Lahore, 1925.

2. Cultivators' Holdings in the Punjab, by H. Calvert, C.I.E., I.C.S. Ibid.

Similarly these enquiries point to the conclusion that the total number of owners, including minors and women, is about 3½ million, and that the number of cultivators is just over 4 million.

If the question of the typical Punjab holding is raised, the answer in the first place must point out that in the 29 districts of this large province many types exist. For example, the typical holding in Kangra is entirely different from that in Montgomery and the Montgomery type would not be that of Mianwali; but bearing in mind these distinctions, depending chiefly on rainfall or on canals, it may be said that the Punjab is a province mainly cultivated in small holdings of between 1 and 20 acres. More than 60 per cent of the cultivated area is accounted for in this way, and about half is found in holdings of 1—15 acres.

Omitting from consideration the 625,000 owners and 900,000 cultivators of less than one acre, the following figures show the percentages of the total number of persons owning or cultivating holdings in each group.

Group.		Owners.	Cultivators.
Holdings of	1 and under 5 acres	49.7	42.4
" "	5 " " 10 "	21.9	26.9
" "	10 " " 15 "	10.3	13.4
" "	15 " " 20 "	5.2	6.8
" "	20 " " 25 "	3.3	3.9
" "	25 and over ...	9.8	5.5

It will be seen that, neglecting the owners and cultivators who have less than one acre of land at their disposal, 81.9 per cent of the remaining owners and 82.7 per cent of the cultivators fall within the 1—15 acre limits.

Outside the canal colonies the holdings of 15 acres and over are usually found where uncertainty of sufficient rainfall makes cultivation precarious, the largest holdings being characteristic of the most arid tracts.

In the canal colonies settlers were originally placed for the most part on squares of about 25 acres; sub-division occurs when sons inherit, but as the colonies are still young the average holding of good land is at the present time substantially larger than in other districts. If we accept these canal colonies, it would broadly be correct to say that the cultivator is always short of land. The increase of the population, which since 1881 has risen by close on 20 per cent, and the fact that industries other than agriculture offer little alternative employment, has resulted in a pressure on the land which, though less than in other provinces still leaves many cultivators with holdings too small for full time occupation.

The pressure of the people on the soil is shown by the following figures: In Sialkot, Amritsar and Jullundur districts there are from 400 to 500 persons to the square mile, and there are localities outside urban influences in these districts where it may even

reach 800. In the dry western districts of Dera Ghazi Khan, Muzaffargarh and Mianwali the population per square mile falls below 100. In general, outside those canal colonies in which population has not yet overtaken production, the density is determined by rainfall and the fertility of the soil. "In India," to quote Mr. Darling, "every advantage of nature is sooner or later neutralised by an increase of population. It may almost be said that the fertility of the land is a measure of the fertility of woman."

The sub-division of land which has taken place because of the customs of inheritance, which give to each son an equal share in the father's land, is made worse by fragmentation. Not only must the value of the property be divided between heirs, but the actual fields themselves are also divided. Thus in such districts as Jullundur where a fertile soil, irrigation from wells, and a moderate rainfall have resulted in a dense population, *the fields have been divided up to an extent which has* offered a severe handicap to successful tillage. It is in this area, as will be noted under Co-operation, that co-operative societies for consolidating scattered holdings have been most active.

The peasant is illiterate, some 4 per cent only of the rural population can read and write; nor, as a rule, does he consider that literacy and land cultivation have much in common. He is still apt to be sceptical of the views advanced by his practical instructors, except where, as in the canal colonies, close contact has been established between himself and the Agricultural Department. But since the 1921 census was taken there are already signs that, as a result of the work of the Co-operative Education and Agricultural departments, his traditional views on education and its value are undergoing change. Men who have been in France with the armies, or who, in search of work, have penetrated to lands as distant as China, Australia or Brazil have returned home with new ideas, and are leavening the too solid mass produced by local tradition and experience. As a cultivator, his virtues are both high and low. The Chinese gardener would find a competitor in the Arains of Jullundur, or the tobacco cultivators of the Chhach; the Jats of the Central Punjab could match themselves against the Kunbis of Gujarat, the Belgian small-holder, or any other peasant who by his industry and skill has made a name for his cultivation; the Rajputs, except that they could not allow their women to work in the fields, would be entirely happy in the agricultural atmosphere of a southern Irish county; and there are tribes, which may remain nameless, who are very successful in supplementing the meagre produce of their land by cattle-lifting.

As a man the Punjab cultivator, especially the cultivator of the Northern Division, has given many proofs of his quality in the Indian army. When on gala days he turns out to compete in an inter-village tent-pegging competition, his horsemanship does credit to the cavalry regiment to which he once

belonged, and on occasions when he displays in public a carefully treasured uniform, the medals on his breast betoken varied experiences gained far beyond his native Punjab.

As a man, too, the Punjab cultivator gives many evidences of human frailty. Without distinction of tribe or religion, he is inclined to indulge in litigation; this being almost his only mental relaxation. He cannot read, he does not listen to weekly sermons, the village does not support a theatre, and if strolling players there be, they do not often come his way. On the other hand, pleaders are everywhere, courts are numerous, and argument, though it be expensive, some moneylender will readily help him to buy. His debts, as we shall presently see, are in many cases so heavy that he has no expectation of being in a position to repay them. When, therefore, fortune sends him a good harvest the toil of yesterday and the needs of to-morrow are forgotten; he enjoys himself and spends freely, for what is left over his creditors will annex. If he be a Sikh he may not smoke, if he be a Mahomedan he may not drink, but drink and tobacco are not the only forms of wasteful expenditure open to him; and in buying ornaments and other non-essentials even an orthodox Hindu, who touches neither drink nor tobacco, can, if so minded, dissipate the little store of rupees that should go to reducing his mortgage or improving his land. The thrift of the French or the Scottish peasant is a rare virtue in the Punjab.

He is, as has been said, in many cases an excellent cultivator. He is more careful of his cattle than are most Indian ryots; the working of his land is intelligent, and scientific study in many cases confirms the soundness of the principles which he follows. He displays, however, a certain tendency to let the morrow take care of itself, and this, joined to a lack of business capacity the result of lack of education, and to the simplicity of mind that he brings to bear on the happenings of nature, often proves the undoing of the frugal, hard working Punjab cultivator. His particular industry, in whatever country it is successfully carried on, requires either the possession of capital, substantial in amount in relation to the annual net output, or cheap credit. The capital of the cultivator is in his land, his bullocks, his implements and his seed corn. The major part, that in land and bullocks, is subject to rapid changes in amount. The father, if a landowner, may be a substantial man, his sons, even if only two or three in number, inherit land that may prove too limited for the needs of their families. Cattle disease is rife, and at any time most of his working capital may disappear with the death of his bullocks. Except in the canal-watered areas, shortage of rainfall may cause the crops to fail, and even where canal water is available bad weather may involve poor harvests. Thus, even to the substantial zamindar, credit may become a necessity at some period. Then, apart from his business, there are many calls for ready money. Social obligations involve expenditure on marriages

and funerals, and religious observances must be fulfilled. In no country can social obligations easily be set aside : in India they are a tyranny. The Punjab peasant must pay or become a dishonoured man. These being the conditions under which he lives and works, it is not surprising to find that most cultivators are reduced to borrowing.

Agriculture is the greatest and moneylending the most profitable industry in the Punjab. One cannot readily measure the income derived from moneylending against that derived from agriculture; but it may be noted that income tax collections in the Punjab, in 1925-26, amounted to Rs.9.67 lakhs from bankers and moneylenders, as against Rs.8.88 lakhs from all manufacturers and industries. And if on the basis of land revenue collections it is argued that agriculture in the aggregate must show a much greater gross income than moneylending, the investigations of Mr. Darling and others may be cited to prove that it is mainly into the pocket of the moneylender, and not into that of the cultivator, that the actual profits of agriculture now find their way.

In examining the work of the co-operative societies it will be found that there are exceptions; but as a broad general statement it is correct to say that once the cultivator falls into debt the difficulties of clearing himself are very great. Compound interest at high rates, the uncertainty of harvests, the cultivator's lack of literacy and of account-keeping of any kind, the immediate calls for cash which even a frugal man must inevitably experience, and the system on which the lending business is worked all combine to make the moneylender master of the situation. As the lender's policy is to remain master, and to increase the amount of the capital lent, rather than to call up loans, the volume of indebtedness grows; it has grown rapidly in recent years because the rise in the value of land has added to the security which the debtor can offer.

In the absence of thrift, agriculturists must have credit, and until he is replaced by other means of credit the moneylender must remain an essential partner in the agricultural industry. From the point of view of the industry (as distinguished from the point of view of the cultivator himself) the serious matter is that the moneylender is a bad partner. He gives credit of the wrong kind, it is of the seductive type so often fatal to the thoughtless borrower, and he takes no care to see that his loans are applied to productive purposes. It is all one to the moneylender whether a peasant borrows for the purchase of bullocks, or for the marriage of his daughter, for the sinking of a well or for carrying on a law suit. The result is that land in the Punjab bears a dead load of unproductive debt, which greatly hampers the efforts of those who are endeavouring to promote the prosperity of the cultivator.

In illustration of the evil a few facts from Mr. Darling's book may be cited.

The total average mortgage debt on Punjab cultivated land is Rs.31 per acre or twenty times the land revenue. In general the higher the security available the greater the debt. Thus, in such districts as Amritsar and Gurdaspur, where the soil is fertile and irrigation is practised, it rises to Rs.66 and Rs.49. In the poor, unirrigated districts of Dera Ghazi Khan and Hissar it falls from Rs.13 to Rs.6 per cultivated acre. There are exceptions to this rule, e.g., in the fertile colony land of Lyallpur it is only Rs.20, but Mr. Darling points out that the colony is young, and that most of the causes of indebtedness have not yet arisen there. A very interesting contrast is drawn between Lyallpur and Ferozepore, two districts enriched in recent times by canal water. In the former picked colonists, favourably situated, have amassed wealth, and incurred little debt; a good deal of the money borrowed has, moreover, been borrowed for productive purposes. Here there is real prosperity. In Ferozepore water, coming through the exertions of canal engineers, was accepted by the people as a windfall from heaven. There was a great expansion of the cultivated area, and with high prices and improved communications a marked increase of wealth followed, accompanied as usual with a corresponding development of credit. In spite of epidemics, there has been a considerable increase of population, but not as yet sufficient to counterbalance the increase of area under crops; many of the people became relatively wealthy, but others have succumbed to the temptations of a too facile credit, and the district has now the largest mortgage debt in the province although it is one of the most prosperous. In an enquiry which embraced 1,941 landowners, only 9 per cent were found to be free of debt, and the average debtor owned Rs.655. It is estimated that the total debt, secured and unsecured, in Ferozepore district must amount to Rs.7 crores, or to 38 times the land revenue. Careful inquiry suggests that little of this heavy debt has been incurred for productive or even useful purposes. Much is due to extravagance, a certain amount to expenditure regarded as necessary, and a small proportion to the satisfaction of agricultural needs.

The total debt of landlords in the Punjab is estimated by Mr. Darling at Rs.90 crores. The interest payable on this debt is a huge sum. It is not possible to estimate the average rate of interest with any accuracy, but it is believed that it cannot be less than 25 per cent. If the interest is unpaid it goes to swell the loan; thus it may be stated that the interest now accruing annually on zamindars' loans must be about Rs.22 crores, or five times the land revenue of the province and about seven times the income-tax collections.

With the establishment of British rule and peace in the Punjab, land, which before that time had had little or no market value, began to rise in price, and its importance as a security soon attracted the moneylender's attention. In the

last quarter of the nineteenth century it had begun to pass in alarming quantities into the hands of this class, who did not cultivate it themselves but leased it to tenants, with the result that there appeared a danger of the land passing from the ownership of the hereditary cultivator, an economic revolution which could hardly be regarded without misgiving. To check this tendency the Punjab Alienation of Land Act, 1900, which is referred to on a later page, was passed and a check imposed upon mortgaging to non-agriculturists. Echoes of the grave situation may still be heard in the country-side in the folk-song :—

Je âna hōnda Thorburn

*Tān hōndi Pindi Chaur-Chapat.**

Whereas in 1901 about 3,250,000 acres of land were mortgaged, by 1924 the area had fallen to 2,900,000 acres, but as land has risen much in value, the mortgage money, on transactions in 1901 was about 53 times the amount of the land revenue due on the property, and in 1924 was no less than 127 times the land revenue on the area mortgaged in that year. Mortgaging to neighbouring cultivators has, since 1901, become a very common practice; an enquiry made in Ferozepore district disclosing the fact that zamindars were there exchanging property so freely that land had in effect become a new form of currency.

In describing co-operation further reference will be made to the cultivator's financial position; enough has been said here to indicate that the Punjab peasant, and those who work for his betterment, have difficulties to contend with which cannot be ascribed to the soil, or climate, or even, as many reformers would have it, to the Government, but are inherent in himself and in his relations with his neighbours.

6. THE AGRICULTURAL AND VETERINARY DEPARTMENTS.

A description of the work of the Agricultural Department will be found in the evidence given by the Director of Agriculture, and the Principal and members of staff of Lyallpur College. As an introduction to this evidence it will be convenient to summarise here the main facts relating to the history and activities of the department. The work as now planned falls into three sections—investigation, education and propaganda. It centres round the Agricultural College at Lyallpur and a reference to this institution and its development may first be made.

Work at Lyallpur began in May, 1901, when the Director of Land Records and Agriculture established there an experimental farm of 54 acres, representative of the colony-land watered by the Lower Chenab canal. In 1905 a technical deputy director of agriculture was appointed, and the farm was enlarged to

* If Thorburn had not been there, Pindi (district) would have gone to pieces.

300 acres. At this time the Government of India resolved on a forward agricultural policy and provided for the purpose 20 lakhs of rupees per annum. Of this sum 2½ lakhs were assigned to the Punjab. A college at Lyallpur was then planned at an estimated cost of 4 lakhs and the buildings were completed and occupied in 1909. Meantime, in the autumn of 1906, a professor of agriculture and a chemist began work at Lyallpur and in the following year an economic botanist was appointed. These officers were engaged in investigations to be subsequently referred to until, in 1909, the college was ready to receive students.

A large number of candidates, some 400 in all, applied for admission to the new college, but in the first year the entry was limited to 16 students. A three-year diploma course was planned, partly to train workers for the Agricultural Department, and partly to meet the assumed demands for instruction of sons of the larger cultivators in the canal colonies; but, as elsewhere in India, it was found that government service was the goal of all candidates for admission, and when it was discovered that the demand for government officials was quite limited, requests for admission to the three-year course fell off rapidly, until in 1913 there was not a single applicant. This led to a revision of the courses. For those who desired an extensive training, with the object of qualifying for the better posts in the Agricultural service, a four-year diploma course was offered; for others, whose school qualifications, or whose means made the study of the sciences bearing on agriculture impossible, there was provided a two-year course in practical agriculture leading up to a college certificate. A few of these certificate students were to be eligible for employment in the department's lower posts; the others were expected to go back to the land. Finally, in 1917, the college was affiliated to the Punjab University and the four-year diploma course was remodelled into a course leading up to a B.Sc. degree in Agriculture.

In addition to the four- and two-year courses, there are three shorter courses of study. The first of them to be provided was a six months' vernacular course intended for zamindars' sons. It was begun in 1912, and is well attended. In 1918 a one-year course was instituted for training certificated teachers to give agricultural instruction in the rural vernacular middle schools which have already been described. In 1916 a one-month course was instituted for recruits to the Indian and Provincial Civil Service in the Punjab, with the object of explaining to young administrative officers the scope of the department's activities and the possibilities of improvement offered by local agricultural practices. Experience has shown that officers who have gone through this course have subsequently done valuable propaganda work.

In recent years applications for admission to the college have varied from 108 to 300, and the number annually enrolled from

53 to 64. In 1926 there were on the college rolls 261 students, viz. :—

Degree course students	162
Two-year certificate course students	23
One-year teachers' course students	32
Six-months' vernacular course students	43

The average cost of education to students attending college courses is Rs.45 per mensem. Scholarships are awarded by Government and by district boards. The aggregate annual value of these scholarships is about Rs.16,700.

The increase in the attendance at the college has necessarily involved addition to laboratories, class rooms and hostels. The residential accommodation in 1926 provided rooms for 186 students, and a new hostel, now building, will house a further 126.

Lyallpur provides the Punjab with both a college and a research institute. The staff is common. With the increase in the college itself there has been a large increase in the amount of experimental work. The teaching, research, field experiment and clerical officers now number 160 and there are, in addition, some 280 laboratory attendants and workmen either employed in the buildings and on the experimental fields, or working in the province from the college as headquarters.

The original 54 acres of land taken up in 1901 for experimental work have now been extended to 761 acres which are used as follows :—

	<i>Acres.</i>
College experimental farm	460
Students' training farm	71
Dairy farm	20
Botanical research	110
Entomological research	4
College site and grounds, staff bungalows	96

With the exception of a small piece of sandy land above the level of the canal, the whole area is irrigated, and it consists of a level tract of deep alluvial soil, light in texture, and admirably adapted for experiment work. The absence of rain, the facilities for irrigation and the easily-worked soil enable markedly uniform crops to be grown. The absence of variation in individual experimental plots is in striking contrast to the results that must usually be expected on the undulating fields and in the uncertain climate of Britain. The general impression given by the college estate is that here the experimentalist works under very favourable conditions. Insect and fungus pests have to be reckoned with; but the facilities for study afforded by the adjacent laboratories, and the equipment at the disposal of the college, enable most of them to be kept in control. The farm buildings are extensive, there is available a wide range of European, American and Indian cultivating and other implements, and there are workshops in which repairs can be carried

out. It is on this college estate that the improvements recently introduced into Punjab agriculture have mainly originated, and some account of the work may be given before referring to the district agricultural work being carried on in the province.

If the college estate can claim to be the focus of agricultural activity in the Punjab, the botanical research area may claim to be the focus of the estate. Cotton and wheat have received, and still receive, most attention; but the improvement of a number of other crops is undertaken. Quite recently, under an arrangement made with the Indian Central Cotton Committee, cotton has been given a section to itself; a cotton research botanist has been appointed, a new laboratory has been built, standing in its own 18-acre experimental field, and a farm of 200 acres has been acquired a few miles from the college for the further testing of the new cottons being introduced. From 1907 until 1923, however, cotton improvement formed a main preoccupation of the economic botanist.

In 1907, when botanical work began, two classes of cotton were found growing in the Punjab; by far the most common was the native Indian or *desi* crop, consisting of short staple growths of the species *Gossypium neglectum*, or less commonly *G. sanguineum*; the other was a cotton of American origin (*G. hirsutum*) which had reached the Punjab from various sources, mainly from Dharwar. This American cotton was grown under irrigation in several districts, but was in no great favour with cultivators, and making little headway. On examination by the economic botanist, it was found to consist of a mixture of types, some of them obviously of a superior quality. In 1910 seed of a promising type which had then been selected from the mixture was passed on to be tried on the experimental farm, where it proved to be of high value. It was distributed to cultivators as Punjab-American 4-F and it found so much favour that in 1926 over a million acres of this variety was grown in the province. Meanwhile, as the result of further study, several other cottons of still better quality were isolated from the same group, and two of these, 285-F and 289-F, are being grown on a considerable scale. The staple of ordinary *desi* cotton measures from .5 to .7 of an inch and spins from 6s to 10s counts. Punjab-American 4-F has a staple of about .9 of an inch and spins from 20s to 25s counts, and 289-F has a staple of 1.2 inches and spins from 50s to 60s counts.

About one-half of the cotton area of the Punjab is still occupied by *desi* cottons, and it is unlikely that they will be superseded, for the American types are not suited for unirrigated land, and even where irrigation is available local conditions may indicate the indigenous types as the more suitable, since they admit of later sowing. Attention has, therefore, been given to the selection of superior strains. While no such marked improvement over the ordinary crop has yet been secured as in the case of exotic cotton, the mixed country

cottons have been separated into four more or less pure strains, each possessing some quality commending it to the cultivators of some locality, and it is anticipated that as a result of further study superior strains will yet be discovered.

It should be noted that the improvements in cotton so far effected have resulted from the discovery, isolation and growing on of superior strains occurring naturally in field crops. Hybridisation is now being resorted to in the hope of artificially producing new strains of better quality than those found in the existing crops.

Work on wheat has followed the same lines as in the case of cotton. From 1908 onwards a study was made of the types discovered among mixed field crops and many were isolated. The first to show high merit was the wheat known as Punjab No. 11 which, in 1926, occupied some 625,000 acres. This wheat was one of those originally isolated by Pusa investigators; but it showed no special merit in the Pusa district. Proof of its value for the Punjab was obtained at Lyallpur. By continued selection a second wheat of much value—Punjab 8A—was isolated. It is not only a better yielder, but produces a better flour than No. 11, and it is superseding this variety. In 1926 some 880,000 acres were being grown from seed supplied by the department.

Just as the best wheats distributed widely by Pusa, and largely grown in the United Provinces and elsewhere, have not commended themselves in the canal colonies of the Punjab, so the best Punjab wheats are seldom popular further south, and not even in the Peshawar valley in the extreme north. This illustrates a general experience among agriculturists. By whatever process a new variety may originate, whether as the result of selection or of cross-breeding, its value to a locality can only be determined by rigid tests conducted in that locality. It is recognition of this fact that governs much of the experimental work at Lyallpur. The larger part of the botanical area (as distinguished from the area assigned to the special officer in charge of cotton) is now occupied by an extensive series of selections of wheats; some of them picked out from existing crops, others the result of hybridising. The special qualities of these wheats are carefully noted, the most promising are passed on to the experimental farm, and there, after further tests, if they prove satisfactory, are multiplied for distribution to seed-growing farms in different parts of the province.

The work of the chemical section at Lyallpur, like that of the botanical, partly consists of intensive studies of subjects to be further worked out on the experimental and dairy farms, and partly of work arising out of investigations in progress in other parts of the province. As an illustration of the former type of work may be instanced the investigations now in progress on animal nutrition. The digestibility of the more important feeding stuffs is being determined by trials conducted on cows

and bullocks; while the effects of foods on milk production, and the feeding value of new types of fodders—with special reference to materials that might be employed in times of scarcity—have recently received special attention. A new digestion stall accommodating six animals, with facilities for the separation of dung and urine, has been provided for these experiments on cattle.

Investigations of the second type, that is, work carried out at Lyallpur in association with experimental farms, or observation plots in other parts of the province, now cover a wide range of subjects. The nutrition studies are being extended to samples of fodder from all parts of the Punjab; while it is worthy of note that special attention is being given to the mineral content of the natural grasses in districts where there is reason to suspect deficiencies. Co-operative manurial experiments are conducted, green-manuring, and the uses of ordinary artificial manures have been investigated. A sugarcane survey has been undertaken, and many local and introduced varieties have been analysed. Waterlogged soils and salt lands have been examined, and special experimental treatment has been devised with a view to the reclamation of such barren lands. A large number of samples of Punjab soils have been collected and analysed.

An entomological section has been at work since the college started; in 1919 it was reorganised and much enlarged, and now, in addition to teaching and research work at Lyallpur, it employs a staff for dealing with insect pests in the province. Under its supervision many thousands of fruit trees are sprayed each season. At the present time, in association with the Indian Cotton Committee, much time is being given to studies of the pink cotton bollworm, whose ravages are specially severe in the south-eastern Punjab. The adjacent tracts of the United Provinces also suffer from this pest, and parallel studies of methods of control are being made at Cawnpore. Treatment of cotton seed with hot water before sowing has been found very useful. Other insects now receiving special attention are cotton-, sugarcane-, maize- and rice-borers, and fruit pests such as the mango hopper and the psylla of citrus trees.

With the object of studying the feeding-habits and life-histories of injurious insects, an insectary has been provided, and four acres of land are set aside for observational and experimental work.

The section is also charged with fostering sericulture and lac cultivation in the province.

An agricultural engineering section was started in the college in 1915, and in 1920 new workshops were provided with offices for draughtsmen and clerical staff. From this centre the work of improving irrigation from wells within the province is conducted. Special attention has been given to increasing the water supply in ordinary wells by boring, and to providing deep

tube wells, where these are suitable. A new power-boring machine has been designed, and an improved type of strainer for preventing the choking of bore holes with fine sand has been introduced. Three power-boring machines and 72 hand-boring plants are now at work, and the number will shortly be increased to 10 and 140 respectively.

Hitherto the demands on the time of the engineer in connection with well-irrigation have not allowed of much attention being given to the designing of new machines and implements; but a special engineer is now to be employed on this work, as the experience already gained shows not only that there is scope for better designs, but that with skilled assistance it will not be a difficult matter to effect improvement.

The large experimental farm is employed in testing and developing the work of the laboratories and research fields, for in dealing with Indian cultivators it is of special importance that nothing which has not been thoroughly tested should be brought to their notice.

The farm consists of two sections. About half is leased out to tenants and the remaining half, the most suitable for experimental work, is laid out under crop-variety tests, rotation experiments, manurial trials, and irrigation experiments. From what has already been said on the work of the scientific sections, the scope and purpose of the experiments will be inferred, and one experiment only, that on "Intensity of Cropping," need be referred to because of its general interest.

In Indian agriculture fallowing takes an important place as a means of cleaning and improving land; but it is known both that Indian soils are specially deficient in humus, and that there is in them a large production and loss of combined nitrogen. It was therefore argued that provided the land can be kept clean, the greater the intensity of cropping the better the result should be, for root residues would add humus and the growing of crops would prevent the loss of combined nitrogen. To test the correctness of this theory, advanced by the then Professor of Agriculture, a series of rotation experiments was planned in 1920. About 25 acres of level and uniform land was divided into four blocks which may be designated as R1, R2, R3 and R4. Each block carried a three-year rotation of crops. The first of these was a common local rotation wheat—fallow—cotton. The fallow was relied on for land improvement, and it will be seen that the intensity of cropping was 66 per cent. R2 consisted of wheat—gram—cotton; thus the intensity of cropping was 100 per cent and a leguminous crop was relied on to effect improvement. R3 consisted of a leguminous crop, *guar*, ploughed in, followed by wheat—rape cotton; intensity of cropping 133 per cent with a leguminous green manure to effect improvement. R4 consisted of wheat—mixture of *fowar* and *guar* (for fodder)—gram—cotton—*senji* (an annual medick); here the intensity of cropping is 166 per cent, three

leguminous crops are grown, and additional fertility has been imparted by the direct application of 10 tons per acre farmyard manure to the cotton crop.

The financial returns for two three-year rotations are now available and are as follows:—

						First rotation.		Second rotation.	
						Rs.	As.	Rs.	As.
R1.	Average net income per acre per annum	...	...	...	...	36	13	95	3
R2.	Ditto	...	...	...	...	45	2	115	11
R3.	Ditto	...	...	...	...	56	4	124	15
R4.	Ditto	...	...	...	...	66	5	152	3

It will thus be seen that the more intense the cropping, the greater was the net income, and also that the final figure suggests a marked increase in value to be due to the direct application of farmyard manure.

The above experiment has been referred to as an illustration of the work at Lyallpur, but the results are of much general interest as bearing on the possibility of increasing production on irrigated land. Given water, active bullocks and seed of the right kind, there would seem to be no reason why cropping should not be intensified, and fertility enhanced, by following methods suggested by sound theory and approved by six years' practical experience.

The section of the experimental farm which is let out to tenants is not let unconditionally, but is used to promote the objects of the department. New varieties of crops, which show sufficient promise under experimental conditions, are passed on to the tenants so that their value, under the ordinary methods adopted by the Punjab cultivator, may be ascertained before they are distributed to the agricultural public.

While the stock and crops on the experimental farm are available for teaching purposes, they are not subjected to the prentice hands of students. For giving practical instruction, so very necessary in the case of Indian students, there is a farm of 71 acres worked by the students themselves, who are required to undertake all the usual farming operations, including the care and feeding of the working cattle.

Side by side with the development of the investigations and educational work at Lyallpur there has gone on an expansion of district work. Some reference to this has been made incidentally in describing the activities of the college. It will now be necessary to allude further to the work proceeding within the province.

In July, 1906, a separation was effected between the Departments of Land Records and Agriculture, which had hitherto been under a single director, and a director of agriculture—an Indian civilian—was appointed. When in the autumn of the same year a principal was appointed to Lyallpur, the

deputy director, who had previously taken charge there, was set free for work throughout the province. In the following year the Secretary of State authorised the employment of three deputy directors, but it was not until 1914 that the third appointment was made. The province is now divided into five circles, each in charge of a deputy director, and proposals have recently been made, and approved in principle, for the employment of three additional deputies. The present organisation, however, is on the basis of five circles, the headquarters of the deputy directors being Gurdaspur, Hansi, Montgomery, Multan and Lyallpur. Subject to the general supervision of the Director and assistant director, whose headquarters are in Lahore, the five deputies are responsible for all the work proceeding in their respective circles, except that in the case of Lyallpur the college—the focus of all this district work—has its own Principal. The five deputies are members of the Indian Agricultural Service with salaries (exclusive of overseas pay) rising from Rs.350 per mensem to Rs.1,250 as a maximum. Immediately under them are nineteen extra assistant directors stationed at appropriate centres throughout the province, who are members of the Provincial Agricultural Service drawing salaries of Rs.200 per mensem rising to Rs.750 as a maximum. Under the assistant directors there is a corps of agricultural assistants, separated into two groups. Group A consists of men who have passed the B.Sc., or diploma examination, or who have been promoted for special merit. They begin on salaries of Rs.100 and may rise to Rs.300 monthly. Group B consists of men who have taken the college certificate after a two-year course. They enter the service at Rs.70 and may rise to Rs.180. Including the assistants stationed at and working from the college as a centre there are now some 140 in the A and 50 in the B Class.

The provincial staff is employed in managing seed and experimental farms, in conducting local experiments and in lecturing and propaganda. A large extension in district work including the provision of many more farms is, as already stated, in contemplation; for the present the facilities for local experimental and other work are the following :—

In the First, or Gurdaspur Circle, there is an experimental farm at Gurdaspur of 161 acres; six government or district board farms of from 43 to 54 acres, located at suitable centres throughout the circle; a seed-growing and experimental farm of 500 acres at Sargodha, and a second farm of 250 acres of the same type at Chilianwala. In the Second (Hansi) Circle, there are at Hansi itself an experimental farm of 589 acres, and three local demonstration farms of 40, 52 and 100 acres respectively. In the Third (Lyallpur) Circle, in addition to the properties attached to the college, there is a seed-growing farm of 878 acres. In the Fourth (Montgomery) Circle are two seed-growing farms of 250 and 275 acres respectively, a district

board demonstration farm of 46 acres, and an experimental farm of 558 acres which has a special problem the reclamation of *bara* land, that is, land with a high percentage of salt and a peculiarly intractable texture. In the Fifth (Multan) Circle there is a seed-growing farm at Multan, and a demonstration farm at Mianwali.

To this list of permanent centres for developing the agriculture of the province, there must be added the livestock improvement farms, which will be referred to subsequently, and the grantee farms, the latter, of which there are about half-a-dozen engaged in crop improvement, consist of large tracts of land varying from about 2,500 to 7,500 acres granted on condition that the grantees take a share in experimental work, demonstration, and seed-growing. These large and well-managed farms have been of special value to the Agricultural Department in testing out new processes, in growing on pure strains of seed, and in providing data for estimating the cost of production of crops. As showing the relation between science and practice in the province, it is interesting to find that two of these farms extending to some 10,000 acres, one leased by a British company, the other by a substantial Indian landowner, are now under the management of a former member of the college staff, and that the size of the crops and the success of the farming are attracting widespread attention.

It is unnecessary to refer here to the character of the work for improving crop-production that is being carried on by the Agricultural Department. It is described in the evidence and its general nature may be inferred from the facts already given; but it should be noted that in addition to the problems of crop-growing, the officers of the department have given close attention to questions of marketing. It was found, for example, that the spread of improved cotton was being hindered by malpractices, or by carelessness. Traders could be induced to offer no more for the small quantities of high-grade cotton produced in the earlier years than for unimproved country cotton; and, when the bulk of the long staple variety increased, the practice of mixing good or bad staples was reflected in the prices procurable by the grower. Special steps were therefore taken to organise auctions of Punjab-American cotton and to safeguard its reputation. This action by its effect on prices markedly assisted the spread of the new introduction.

Livestock Farming and Veterinary Work.—Schemes for the improvement of livestock are carried out by the agricultural civil veterinary and co-operative departments who attack the problems presented from different angles and work with a common policy.

The breeding of improved livestock is undertaken by a special branch of the Civil Veterinary Department, a department whose staff at present form a separate service under a Chief Superintendent, linked to the staff of the Agricultural Department

through the Director of Agriculture, who is in turn responsible to the Minister of Agriculture for the work of both services.

The improvement of cattle presents, as elsewhere in India, much more serious difficulties than the improvement of crops. Although the native breeds of the Punjab are among the best cattle to be found in India, there exists here, as in other parts of the country, the difficulty of providing fodder throughout the year; indeed, owing to the dry climate, scarcity is more pronounced than in many provinces. Before the wide expansion of cultivation rendered possible by the extension of canal irrigation, the need for plough cattle was much less than it now is. Formerly there were extensive areas of waste land, over which wandering herdsmen roamed in search of fodder for their livestock; natural selection played a part in the survival of the fittest, i.e., the most active and enduring of the cattle, and the herdsmen themselves were not devoid of the eye and instincts of the breeder. As population increased and man came into competition with his cattle for the scanty produce of the soil, the lot of livestock became harder; but when the British first reached the south-east Punjab, they found there as fine a class of bullock for military transport as India could then produce; and in the dry district of Hissar, they established a great farm of 42,000 acres for breeding these Harianna cattle for the army. That farm still exists. Some twenty-five years ago it was handed over to the Punjab Government, and it is now used for breeding Hissar bulls for distribution to district boards working livestock improvement schemes. Unfortunately, throughout its long history the Hissar herd has not always been wisely managed; the passion for experiment has at times prevailed over the knowledge of the cattle-breeder. Cattle of good quality from other parts of India were introduced, and crosses appear to have been made—as they are still being made in some parts of India—just to see what would happen! As a result the Hissar herd lost some of its original characteristics. The policy, which has been followed since the present management took over charge of Hissar farm, has been to restore the herd to the original Harianna type; and except in the case of a few of the older cows, the Hissar cattle now exhibit that degree of quality and character which should be regarded as essential in a herd maintained for the production of bulls for the improvement of draught-cattle. The best of the young bulls left when fit for service are sold at an upset price to representatives of district boards and co-operative societies responsible for cattle improvement. The supply is not equal to the demand, and efforts are directed towards supplying those villages where the best use is made of good bulls. The chief difficulty met with in the initial stages of improvement is that many of the village cows are so poor in quality and so badly fed that there is no chance of a satisfactory calf, however good the bull. In the better organised districts, measures are taken to prevent pedigree bulls from being mated

with valueless cows. A second difficulty lies in the existence of worthless wandering bulls. There is no certainty that a cow, itself the result of a satisfactory mating, may not be served by one of these; alongside the campaign for the better treatment of cows, there is also carried on a castration campaign, for reducing the number of inferior bulls. Where, as in Gurgaon district, both these difficulties have been resolutely tackled, a rapid improvement in livestock may be looked for, and there is a keen demand for more Hissar bulls by district boards and livestock improvement co-operative societies.

The total size of the Hissar herd is about 4,000, the number of cows 1,450, and the number of young bulls suitable for service sent out in the year 1925-26 was 406. There has recently been a rapidly increasing demand; but the supply falls far short of the needs. The actual number of Hissar bulls at stud is at present under 2,000. It was estimated in 1920 that the province as a whole requires 50,000 bulls; and even if it be assumed that cattle of the Hissar breed are suitable for distribution in not more than one-third of the province, it will be obvious that a largely increased supply of pedigree animals of this breed is required. The Hissar herd is to be enlarged; meantime the Civil Veterinary Department are developing ancillary farms. Grants of land on special terms are made to agriculturists who undertake to breed Hissar cattle. At present three of these farms, of an aggregate area of about 5,250 acres, and maintaining 925 Hissar cows, have been established in the Lower Bari Doab canal colony.

In the north of the province there is found a second breed of draught cattle—the Dhanni—very different in appearance and qualities from the Hariana or Hissar type, and as popular with cultivators in the north and western districts as Hariana cattle are in the south-east Punjab. A start has been made in the improvement of these cattle by using selected Dhanni bulls. Cattle-breeding associations have been formed in the Rawalpindi, Attock and Jhelum districts. A herd book for Dhanni cattle has been established. Approved bulls are allocated to selected villages. These bulls are the property of private owners to whom a premium is paid in aid of maintenance; the premium may be as much as Rs.20 per mensem.

A third notable breed of cattle found in the Punjab is the Sahiwal or Montgomery. This is one of the few Indian breeds that possesses good milking qualities, and in recent years the native stock has been much depleted by sale to town dairymen, or to Military dairy farms. To preserve the quality and maintain the supply of this breed the Civil Veterinary Department have established five farms in the Montgomery district. These farms maintain some 1,200 pure bred cows and have an aggregate area of about 12,000 acres. In addition government land is being leased out to members of certain cattle-breeding tribes

on the condition that they maintain a specified number of Montgomery cows for breeding pure stock. With the object of encouraging the improvement of milking cattle the department is, at Hissar and elsewhere, also resorting to milk-recording.

The total number of selected bulls provided under the Government's cattle-breeding schemes in 1925-26 was 616, and on the 31st March, 1926, there were 2,253 stud bulls owned by local bodies undertaking cattle improvement. Gurgaon district alone had 463.

To a limited extent the improvement of sheep is receiving attention. The Hissar farm maintains a flock of from 450 to 500 ewes. Merino rams have been used in crossing and selected rams from the cross-bred flock are being supplied to a few co-operative societies formed for promoting sheep farming; but considerable results cannot yet be claimed.

Hissar farm breeds a small number of Arab horses and donkey stallions for mule breeding; but with this work the Civil Veterinary Department have now little direct connection. Horse and mule-breeding operations were, in 1903, transferred to the Army Remount Department which has organisations for the purpose in twelve of the Punjab districts. As in other cases, grants of government land have been made to private individuals on condition that they co-operate with the Remount Department. In the Lower Jhelum and Montgomery district alone some 300,000 acres are being granted on certain conditions to cultivators who engage in horse-breeding, and in the Lyallpur district some 40,000 acres are similarly granted in aid of mule-breeding.

The main work of the Civil Veterinary Department is not the breeding of livestock but the prevention and treatment of disease, and here, as in the case of the Agricultural Department, a reference may first be made to the college. Among Indian educational institutions this college has quite a long history; it began in 1882, when a veterinary school was founded to provide a two-years' vernacular course. This course was in 1899 increased to three years. In 1919 the scheme of training was entirely remodelled. The school, affiliated to the university, became a college; the course was extended to four years, and English replaced Urdu as the medium of instruction. The standard for entrance was henceforth the matriculation examination of the university, and the diploma of L.V.P. (Licentiate in Veterinary Practice) was offered to successful students. Since that time the college has been provided with extensive and well-equipped buildings; including not only classrooms, teaching laboratories and hospitals, but research laboratories, much exceeding in spaciousness and material opportunities for study anything that the veterinary colleges of Great Britain can show. In 1926 the staff consisted of a principal and eight professors, and there were 112 students on the college roll, of whom seven had already taken the diploma and were engaged in advanced studies. From 4,000 to 5,000 cases of

disease are annually treated in the hospitals. For the study of surra a special laboratory was established in the north of the province. Valuable work was done which, unfortunately, has been interrupted by the resignation of the officer in charge.

As in the case of agriculture, the students look forward mainly to government employment for a career.

For veterinary work the province is divided into three Circles each under a superintendent, one of whom is also Chief Superintendent of the department. The Superintendent of the Northern Circle is also responsible for work in the North-West Frontier Province. Each superintendent has under him a deputy, and the provincial staff includes 27 inspectors, 7 veterinary assistant surgeons, and 226 veterinary assistants. In association with district boards, who establish and maintain veterinary dispensaries, this staff is engaged in treating sick and maimed animals all over the province, and in combating as best they can the spread of contagious disease. In the absence of legislation on the lines of the Contagious Diseases (Animals) Acts of Britain, it needs no description of their task to prove that the difficulties under which veterinary officers work are formidable.

Diseases are treated partly by members of the staff of the Civil Veterinary Department on tour, and partly at local dispensaries to which sick animals are brought. In 1925-26 the touring staff visited 22,600 villages, treated 120,000 sick animals and castrated 90,000 scrub bulls or bull calves. The veterinary hospitals (of which there are now 191), and the dispensaries had 24,000 in-patients, 574,000 out-patients and castrated 76,000 animals, of which 64,000 were cattle. Some 230,000 cattle were inoculated with scrum (alone) against rinderpest, and 92,000 against hæmorrhagic septicæmia, and against the latter disease 148,000 were vaccinated.

The cost to the central Government of the Civil Veterinary Department was Rs.12.93 lakhs in 1925-26, hospitals and dispensaries accounting for 3.17 and livestock breeding and improvement for 6.16 lakhs. In addition, local bodies expended 2.75 lakhs on hospitals and dispensaries, and 2.87 lakhs on livestock improvement.

Horticulture.—It is recognised that there is a wide field for the fruit and vegetable grower in the Punjab, and the difficulties of the horticulturist are being met to some extent by the Entomological and other specialist sections of Lyallpur College. On the cultural and crop-improvement side a small amount of work has been done by the Economic Botanist, such, for example, as the introduction of the Arabian date-palm into Muzaffargarh; but it is agreed that much more requires to be done, and it has recently been decided to add fruit and vegetable specialists to the agricultural staff.

Pending further developments within the department, Government has sought to encourage horticulture by granting leases of State land on favourable terms, on condition that

experiments in fruit-growing are carried out. The most important of these grants was made in 1920. A farm of 720 acres in the Montgomery district was leased to a fruit-grower on condition that he would cultivate grapes and endeavour to establish a raisin industry. Climatic difficulties have been encountered, the ripening grapes are apt to burst during the rains, and varieties which ripen before or after the rainy season are being sought. Other farms of 125 acres and 75 acres respectively have been granted for general fruit culture. In these cases the prospects are more hopeful, but the trees planted are still young and definite success is not yet assured.

This outline of the development of the Punjab Agricultural Department may be concluded by citing the expenditure incurred at various periods as the department grew in size. In the post-War years the increase in salaries and other costs must be kept in mind. Otherwise the rate in growth of expenditure may be taken as a fair measure of the Punjab Government's effort. It will be seen from the evidence of the Director of Agriculture that the claim is made that the expenditure has been highly remunerative, and as Government contemplate large extensions of the department in the next five years, and the Legislative Council have already granted funds for the first part of the new programme, it may be inferred that the province is satisfied with the returns that so far have accrued.

The total expenditure on the Agricultural Department at five-year intervals from 1906-07 onwards is shown below. The cost incurred by other departments in providing buildings or land for the Agricultural Department has been included, but the cost of the Veterinary Department (which has been given above for 1925-26) has been excluded.

						Rs. lakhs.
1906-07	...	...	...	...	...	2.58
1911-12	...	...	...	...	...	3.00
1916-17	...	...	...	...	...	7.05
1921-22	...	...	...	...	...	19.23
1926-27 (Budget Estimate)	...	...	...	...	...	38.46

7. IRRIGATION.

The total area of irrigated land in the Punjab in 1925-26 was 13,819,000 acres. Of this area by far the greater part was supplied with water from the great system of canals. In regions which canal water does not reach, wells are the main source of supply. The total area irrigated from wells in 1925-26 was about 3,715,000 acres as compared with 4,612,000 in 1868-69. Of well irrigation it is unnecessary to write. As in other parts of India, water is lifted by the Persian wheel or the leather bag; bullocks, or occasionally, buffaloes supplying the power. In a few districts oil-engines are employed,

especially for pumping from deep (tube) wells. The main difficulty that confronts the cultivator depending on wells is the lowering of the water-table in certain tracts. Intense well irrigation exhausts the relatively small supplies of subsoil water existing in dry tracts; and the falling, by even a few feet, of the water table so greatly increases the cost of lifting that it may easily turn a prosperous into a wholly unprofitable form of cultivation. Uncertainty as to the water-supply available is now hindering the extension of deep wells, and experimental batteries of tube wells are projected in one or two important districts with the object of testing the effects of intensive pumping on the supplies afforded by shallow wells in the same localities. As will be mentioned later, scientific officers of the irrigation and agricultural departments are studying both the prospects of increasing the number of tube wells and the effects they produce on the subsoil water level.

The distinctive feature of Punjab irrigation is its canal system. While the magnificent waterways which now fertilise the province have been constructed mainly within the past half century, it must not be supposed that canal irrigation in the Punjab is a new thing. The oldest of the existing canals—the Western Jumna—owes its origin to Firoz Shah, in 1351, and its re-excavation and extension to Akbar in 1568. The words of a *sanad* of this great ruler are worth quoting: * “My wisdom,” he writes, “wishes that the hopes, like the fields of those thirsty people, may, by the showers of liberality and kindness, be made green and flourishing, and that the canal may in my time be renewed, and that by conducting other waters into it, it may endure for ages. For God has said from water all things were made. I consequently ordain that this jungle, in which subsistence is obtained with thirst, be converted into a place of comfort free from all evil.” In the seventeenth and eighteenth centuries irrigation was neglected, but early in the nineteenth the canal of Firoz Shah and Akbar was resurveyed and restored by the British engineers, Macartney, Blaue and Colvin, and since that time the mantle of the Mogul ruler has fallen on a succession of British and Indian engineers, so that the Punjab, if not yet “free from all evil,” is rapidly being converted into a province in which subsistence, formerly obtained “with thirst,” is now obtainable in “comfort.” When the projects in course of construction, or investigation, have been carried out, the dream of Akbar will indeed have become a reality.

It is possible to describe in words the Punjab canal system, and to show by figures the magnitude of the engineering works; but it is scarcely possible to convey to those who have not visited the province a conception of the change which irrigation has brought about on its scrub-covered wastes and sandhills. In

* Yule, “*Jour. Asiatic Soc.*,” 1846; quoted by Buckley, *The Irrigation Works of India*, Allen & Co., London, 1880.

regions not yet reached by canals the traveller may still journey by train for hours across wastes consisting, it would seem, of hopelessly barren land; and on the following day, in one of the canal colonies, he may traverse wide tracts, patches of which, here and there left unirrigated, consist of the same thirsty sand, but in general now converted into cornfields so prosperous to the eye of the agriculturist that to describe the change he is compelled to make use of Akbar's imagery. It would seem that not moisture alone but "showers of liberality and kindness" have "made green and flourishing" this barren jungle. But in prosaic terms, the irrigation engineer will inform him that the change has, in fact, been brought about by the supply of 2.84 cusecs (cubic feet per second) of water per 1,000 acres through an A.P.M. (adjustable proportional module) from some minor water channel! What is it that the officers of the Irrigation Department have done and are doing?

Two types of canal may be distinguished. First, there are the inundation canals, many of them ancient, depending for their supplies on flooded rivers. These canals are numerous, but as a class they are unsatisfactory from the point of view of the cultivator, since the water supply is uncontrolled and uncertain and crops are liable to injury by the falling of river levels at critical periods, and, except in the Indus Valley, they will cease to exist when the irrigation programme has been completed. Of far greater importance is the second type of canal, for which by means of head works, a large volume is stored and from which a controlled supply can be provided either throughout the year or for a definite term which will ensure the autumn or the spring harvest.

In recent years the irrigation works of the Punjab have grown quickly and they are still in process of rapid extension. When in 1932-33 the Sutlej Valley canals, now in course of construction, have been completed, the Irrigation Department will be able to claim that they have some 15,000,000 acres annually under irrigation. Included in this large area there will be about 2,500,000 acres situated in Indian States; the necessary construction may, however, be claimed as their work by Punjab engineers; it has been, or will be, carried out by them on behalf of Indian rulers.

In 1924-25 there were in all nearly 20,000 miles of government irrigation channels in the Punjab, as compared with 11,000 miles at the beginning of the century.

Including 679,000 acres in Indian States, the area irrigated from government irrigation works in the year ending March, 1926, was 11,109,000 acres, as compared with 5,244,000 acres in 1900, and 2,341,000 acres only in 1887-88.*

About 5,096,000 acres of *kharif* crops were irrigated in 1925, including cotton, 2,414,000, rice 540,000 and sugarcane 160,000

* The figures for 1925-26 are gross and the earlier figures are net.

acres. In the following *rabi* season 6,013,000 acres were irrigated, including 3,593,000 acres of wheat.

The figures given above relate to the actual areas irrigated in a single year. The total areas commanded by the canals are much greater and these larger areas are irrigated in rotation. At the present time 20 million acres of land are commanded, and when projected canals and extensions have been carried out, this area will be increased to 36 millions. For comparison it may be noted that the irrigation works of Egypt and the Sudan command eight million acres.

Not only have Punjab canals converted sandy wastes into fertile tracts of country, but they have proved directly profitable to Government. On the works in operation at the end of 1925-26, a total capital outlay of about 23.54 crores of rupees had been incurred. By far the larger proportion, *viz.* : 23.15 crores, had been spent on productive works. The direct income in water-rate and miscellaneous receipts from productive works in 1925-26 amounted to 4.30 crores, and the expenditure on maintenance and interest charges to 2.34 crores, thus showing a profit of 8.5 per cent. But in addition there were large indirect receipts in the form of enhanced revenue from the irrigated lands. These indirect receipts were about 2.02 crores, bringing the profits after paying interest charges up to 17.2 per cent.

It should be noticed, however, that the capital outlay per acre irrigated has risen greatly. In the case of four of the older perennial canals, the capital outlay per acre irrigated in 1924-25 was Rs.19, while on four new perennial canals it reached Rs.43. In the case of the Sutlej canals now being constructed, the capital cost per acre irrigated is likely to exceed Rs.80; and other projects under consideration would involve a capital expenditure of Rs.100 per acre irrigated.

The charges made for water are on an acreage basis and the rates vary with the kind of the crop. Remissions are given on account of failure. Typical charges in 1924-25 were for sugarcane Rs.12 per acre, for cotton Rs.6-4, for wheat Rs.5-4, and for fodder crops it has recently been reduced from Rs.3 to Rs.1-8 per acre. Proposals for supplying water on a volumetric instead of on an acreage basis have been considered, but for reasons that will be indicated below the Irrigation Department has hitherto found it to be impracticable in general to change its present method of charging by the acre irrigated.

The chief canals from which water is now being supplied may be briefly referred to.

The Western Jumna Canal is the oldest in the Punjab. It was originally constructed, as already noted, by Firoz Shah in the fourteenth century. The ancient canal was restored by the British between 1817 and 1847, and was further improved and extended between 1873 and 1880. The present canal takes off from the Jumna at Tajewala, commands about 2,700,000 acres

of land in the districts of Ambala, Karnal, Hissar, Rohtak and Delhi, and in the States of Patiala and Jind; but the water available allows only of the irrigation of about one-third of this area in a year. The full capacity is 6,400 cusecs, and this quantity may be available between the 10th of May and the 15th of September. In December the supply may fall to no more than 1,800 cusecs.

Upper Bari Doab Canal.—For political reasons this canal was projected immediately after the annexation of the Punjab. It waters the Doab between the rivers Ravi and Beas in the heart of the Sikh country. It takes off from the Ravi at Madhopur in Gurdaspur district. When full, as it usually is from the 15th March to the 15th December, it carries 6,700 cusecs, but in the later winter months the supply may drop to 1,500 cusecs. It commands some 1,600,000 acres, of which about 80 per cent. may come under irrigation in a year. Rice is an important crop in the area watered by this canal.

Sirhind Canal.—This canal, which takes off from the Sutlej at Rupar in Ambala district, was begun in 1869 and completed by 1883. It commands about 2,450,000 acres in the districts of Ludhiana and Ferozepore and can irrigate about 1,000,000 acres annually. The capacity is 5,600 cusecs, and from May to 15th August there is a full supply of water. This canal also irrigates land in the Indian States of Patiala and Jind.

The Lower Chenab Canal.—This canal was opened in July 1887, but its capacity was greatly increased when the Upper Jhelum was completed in 1915. It now has a capacity of 10,900 cusecs, and irrigates more land than any other. It commands 3,390,000 acres in the districts of Gujranwala, Lyallpur and Jhang, and can irrigate about 2,000,000 acres annually. The months of April and October are critical periods in the Chenab canals, and consideration is being given to a scheme for increasing the existing capacity of the Upper Jhelum Canal, so that more of the surplus water of the Jhelum than is at present possible may be diverted into the Chenab.

The *Lower Jhelum* canal, the first of the snow fed canals, with a capacity of 4,300 cusecs, was opened in 1901; it commands some 1,300,000 acres in the districts of Shahpur and Jhang, and can irrigate about 825,000 acres annually. A full supply of water is available from February until the end of November.

The rapid increase in canal irrigation in the present century is accounted for mainly by the construction of the linked triple canal scheme which waters the central plains of the Punjab. The following figures show the importance of these canals, which were opened between 1912 and 1915.

The *Upper Jhelum* has a capacity of 8,500 cusecs. It commands 600,000 and irrigates about 300,000 acres in the district of Gujrat; the full capacity of the canal can be used from about the middle of February to the end of November. The main

purpose of the Upper Jhelum Canal is to convey surplus water from the Jhelum river to augment by 6,000 cusecs the supplies required by the Lower Chenab Canal.

The Upper Chenab Canal.—This great waterway, with a capacity of 14,400 cusecs, has a double function. It commands some 1,600,000 and irrigates 650,000 acres in the districts of Sialkot, Gujranwala and Lyallpur, and it passes on 7,500 cusecs into the Lower Bari Doab Canal, which, in turn, commands 1,750,000 acres and irrigates about 1,000,000 acres in the districts of Montgomery and Multan.

Three groups of projects are now engaging the attention of Punjab irrigation engineers. There are, as has already been stated, many inundation canals, some ancient, others modern, in the Punjab. One important series depends on the waters of the Sutlej, and the uncertainty of the supply, together with the need for irrigation in new tracts of country, has led to the great Sutlej Valley Irrigation Scheme now in process of construction. Some of the new Sutlej canals have already been opened, and it is anticipated that the whole new system, commanding some 6,000,000 and irrigating 3,640,000 acres annually, will be in operation in 1932-33. A large part of the area to be irrigated (about 2,450,000 acres) will lie within the Indian States of Bikaner and Bahawalpur, which are bearing a proportionate share of the cost. The original estimate of the cost was about 14.6 crores of rupees, but it is now certain that this estimate will be largely exceeded, and a final cost of from 23 to 24 crores is anticipated, of which the Punjab Government's share may amount to about 10 crores.

Several minor schemes for improving the supply from inundation canals are also in progress.

The second type of project receiving consideration, one which demands attention not only in the Punjab but throughout India, is that of water storage. Periods of water scarcity occur on most of the canals, and it is natural that much thought should have been given to storing a part of the water that at certain seasons of the year in vast quantities escapes through flooded rivers to the sea.

When the Sutlej Valley canals have been completed all the winter water supply of the Punjab tributaries of the Indus will be used in irrigation, but only about one-third of the monsoon supply. It is estimated that one-third of the monsoon flood waters must in any case be allowed to escape so as to scour the river channels; but if it were practicable to construct reservoirs, the remaining third might be made available for irrigation. The difficulties presented by storage are formidable. Five schemes have already been investigated, but for one reason or another have not yet been taken in hand. It is confidently believed, however, that the difficulties which the construction of dams

now present will ultimately be solved and that ultimately large additional supplies of water will be available for irrigation.

The most important of these storage projects relates to a dam across the Sutlej at Bhakra, where the river passes through a gorge some 40 miles above Rupar. This dam would be 410 feet high and would impound no less than twelve per cent of all the water which it is calculated might be stored in Punjab reservoirs. After allowing for losses in the canals, it would deliver some 5,500 cusecs of water for 210 days in the year as an addition to the natural flow of about 5,000 cusecs taken from the Sutlej at this point. The water would be used to supplement the flow of the existing Sirhind and Western Jumna canals, and to fill a new Lower Sirhind canal, irrigating *inter alia* the insecure tracts of Hissar district. The entire area irrigated would be about 2,300,000 acres. The immediate obstacle to progress with the construction of the Bhakra Dam is doubt as to the foundations. Geologists have twice examined the underlying strata, differences in opinion have arisen, and a further examination of the site is now being arranged for. An estimate of the cost of the dam and canals was made in 1920, which amounted to 14.4 crores; but revised figures place the cost of the scheme, if carried out before 1937, at about 23 crores of rupees.

The third group of problems now engaging attention relates to the conservation and more effective use of the water at present available. Experience shows that much may be done in this way. If the areas irrigated by canals existing in 1900 be compared with the areas now being supplied, it will be found that although no extra water enters, there has been an increase of about 36 per cent in the area actually benefiting by canal water. Both agricultural and engineering questions are raised in connection with the distribution of water. There are differences of opinion as to the amount of water that crops require, and as to the methods of charging for the water provided. In general, it may be stated that agriculturists are disposed to claim that better results would be got if water were sold by volume and the cultivator left to do what he liked with the supply he received; but engineers argue that not only does the acreage basis afford the only practicable method of charging for water supplied to ordinary cultivators, but that it is the better method for the small cultivator himself. It is agreed that the owner of a large estate, who purchased by volume, would derive advantage from having the distribution of his supply entirely within his own control, and, in fact, a few large owners are now supplied by volume, but it is stated by the Irrigation Department that the advantages claimed for the small man are illusory. The main advantage claimed by advocates of the volumetric system is that it would free the cultivator from the too common exactions of petty officials, who record the area of land he irrigates; but canal engineers

Jumna, Upper Jhelum and other canals. Open drains are mainly relied on, but mole drains and tile drains are being experimented with in saturated fields. In at least one area, Amritsar, pumping from deep tube wells has been successful in lowering the water-table and improving the sanitary conditions of the city and its surroundings, although at a cost that would not have been warranted if agricultural improvement had been the sole objective. When drainage is not available, an effort to control waterlogging in threatened areas is made by suspending irrigation during the *rabi* season.

Apart from the well-known ill-effects produced on most crops by a saturated surface soil, there is in the Punjab a special danger to be apprehended from waterlogging. The deep alluvial soils are frequently charged with large quantities of sodium and magnesium salts; salt or *kalar* soils are common even where the water-table is deep, and when the surface soil, or the subsoil at a depth of a few feet, is saturated *kalar* is almost certain to give trouble. As in other parts of India, remedies have been sought, but the only practicable remedy so far discovered consists in washing out the salts from the surface by free irrigation, and this method to be successful implies equally free drainage.

Irrigation Research Committee.—An Irrigation Research Committee, consisting of a soil expert, specialising in soil chemistry and physics, and an engineer, was set up in 1925 to explore the problems now facing the Irrigation Department. A suitable laboratory has been planned and is being built; and a central field experimental station has been established. Three groups of problems will be investigated, *viz.*:—

1. Movements of the water-table in connection with waterlogging, or desiccation. Waterlogging difficulties have been referred to above; the converse problem, lowering of the water-table to an undesirable degree, owing to the increasing intensity of well irrigation, presents itself notably in the fertile tract round Jullundur. Data for study are available in spring level records kept for many years by the Irrigation Department; and, where no canals exist, from the less exact information collected by revenue officials. To supplement existing data, surveys will be undertaken. There is considerable evidence that the free flow of subsoil water is prevented by the occurrence of impervious strata buried beneath the alluvium. Rock masses might account for the waterlogging of tracts lying upstream and, if their existence were proved at no great depth, remedies for the waterlogging of large tracts might be possible. It is proposed to use the Etvös Torsion Balance in searching for such obstructions to drainage.

2. Hydro-dynamical problems present themselves in the designing of irrigation channels in connection with the movements of silt. The only method of studying these movements in detail is by means of models reproducing under

controlled conditions, the flow of silt-charged water in channels. The new laboratory will provide a hydraulic installation which will enable silt and water movements to be studied in detail.

3. Field investigations relating to the reclamation of waterlogged land are projected. A site has been selected in a locality where much badly waterlogged land exists. Experiments have been planned on mole drainage and tile drainage, in conjunction with a system of open drains. Observations will be made on the behaviour of crops in soils with a high water-table, and, using these observations, crop experiments will be designed which will be conducted at suitable centres elsewhere in the province.

8. FORESTRY IN RELATION TO AGRICULTURE.

The Punjab is poorly supplied with timber; less than 10 per cent of the total area of the province is classed as forest land, and in British territory, under direct charge of the Forest Department, there are only some 4.3 million acres, of which 2.7 million are in the hills and 1.6 million in the plains. The land under forests is mostly open for grazing and grass-cutting, and forms a reserve for fodder supply invaluable in time of scarcity. From 280,000 acres only are stock entirely excluded, but on a further 220,000 acres the grazing period is limited. Thus 3.8 million acres of the land now classed as forest may be regarded as an addition to the area available to the agriculturist. The value of the grazing rights is assessed at over Rs.20 lakhs per annum by the Forest Department. In other directions forests confer direct benefits on the Punjab cultivator. It is estimated that he annually receives 25 million cubic feet of firewood, and a million cubic feet of timber free of charge.

In spite of these benefits, the cultivator, especially in the hill districts, regards the work of the forest officer with disfavour, and the forest officer has too good cause to complain of the destruction done in the areas under his charge, by over-grazing and the careless felling or lopping of trees by villagers. Forest destruction has resulted in widespread erosion of hill-sides in the Siwalik hills, and excessive browsing by goats has greatly reduced the value of the land in other hill tracts. It is of special importance in view of the extension of irrigation on the plains that the rainwater of the hills should sink into the soil and not disappear in torrential floods into the rivers, as it does where hill forests are destroyed; and no less for the sake of the welfare of the cultivator of the plains than for the value of the trees in their charge, forest officers are doing what they can, in spite of local opposition, to conserve and re-establish trees in threatened forest areas. It is from the Forest Department more than any other that complaints

are heard of the over-stocking of grass-land with animals of no economic value, for this is a subject that is constantly being forced upon their notice in the extensive grazing areas which they control.

For the needs of the people, forests in the hill districts are relatively ample. It is in the plains that the great scarcity of timber and fuel reserves is apparent. As irrigation has spread, some 2 million acres of waste land, formerly classed as forest, have been taken up for cultivation, and a further 650,000 acres will shortly be irrigable and used for field crops.

As compensation some 85,000 acres have been, or shortly will be, covered with irrigated plantations, in which the production of firewood and timber will be rapid; but on so small an area even tropical growth must leave the Punjab plains very poorly provided for. It is certain that if the people are induced (indeed before they can be induced) to substitute wood for cowdung as fuel, much larger areas must be set aside for plantations.

In addition to the forests under the Forest Department, there are in the Punjab considerable areas of forests and waste land which come under the Revenue Department and are in charge of the deputy commissioners. The fees received for grazings in 1924-25 amounted to Rs.62,000 and in 1925-26 Rs.66,000. Some forest land is also under Military control. The total area of the forests and waste land under Revenue and Military management in 1925 was 515,000 acres; most of it is of little account as a source of timber or fuel, but about 320,000 acres is classed as "reserved" forest.

9. GENERAL EDUCATION.

"It is suggested that the solution of the problem of rural education is the foundation of all rural progress. The agriculturist is of more importance than agriculture." These words, quoted from the memorandum prepared for the Commission by the Punjab Government, may be taken to show the attitude which the Education Department of the Province adopt to agriculture. They are well aware of the importance of the agriculturist in the community which they serve, of the value of education to him, and of the need for an educational system which will meet his special needs. In recent years close and continuous attention has been given to the problems presented by the illiterate peasant population. Before describing what has been done to promote education in rural areas, a few facts about the educational system as a whole may be given.

The total expenditure on education at recognised institutions in the Punjab in 1925-26 was 256 lakhs of rupees, as compared with 190 lakhs in 1920-21 and 60 lakhs in 1911-12. Of the 1925-26 expenditure, fifty-two per cent was contributed by Government, thirteen per cent came from the funds of district

and municipal boards, twenty per cent from fees and fifteen per cent from other sources. The cost per enrolled scholar was Rs.26-4-3. The average cost per pupil at different types of institutions is stated in the table of figures given below.

In 1921 there was in the Punjab a population of some 11,300,000 males and 9,380,000 females. Of the former 954,000 or 8.44 per cent and of the latter 108,000 or 1.15 per cent were under instruction in 1926.

Of the male pupils about 900,000 or 7.96 per cent were attending institutions recognised by the Education Department. In the following table are given particulars of the institutions, scholars in attendance, and cost per head of each pupil :—

Kind and number of institutions.	Number of pupils.	Percentage at each institution.	Cost per pupil.		
			Rs.	a.	p.
1 University	—	—	—	—	—
21 Arts Colleges	7,883	.82	194	6	0
7 Professional Colleges	1,729	.19	616	7	2
285 High Schools	111,126	12.35	41	5	5
1912 Middle Schools	311,218	34.57	13	6	10
6711 Primary Schools	377,315	41.91	8	10	10
3268 Special Schools	91,386	10.15	10	7	4

The University of the Punjab, Lahore, is at present mainly an examining body. The arts colleges, which prepare students for university examinations, include a new group of seven intermediate colleges, designed to bridge the period between high school and university studies. Largely in the interests of the rural population these colleges have been started at suitable centres so that young boys may not have to leave their own districts for study in the large towns. Two high schools and two college intermediate classes are included in the curricula of the new colleges. Not only do the ablest among country boys thus get an opportunity of preparing for university examinations, but their fellow students, who do not attempt to graduate, get a better education near their own homes than was formerly available. Again, with the object of improving education in country districts new high schools have recently been provided, mainly for outlying districts. A survey of the position of Anglo-vernacular education made some three years ago showed that the richer urban and thickly-populated areas were amply provided for, but that in backward rural areas facilities were "painfully few and far between." By economies effected in expenditure on schools in urban areas, money was provided for extra grants for secondary education in rural districts. In thinly-populated tracts the district boards were found to be unable to support a high school, and at the same time do justice to other forms of

education; in such cases the Education Department provided new high schools supported by provincial funds.

It is not, however, in the high schools and colleges that the interests of the rural population mainly centre. Of far greater importance to Punjab agriculturists are the primary and vernacular middle schools, and it is recognised that, in the past, for reasons which, if not adequate, are easily explained, too much effort has been concentrated on providing higher education for the few, and too little in promoting literacy in their own mother tongues for the people of the province. A determined effort to repair the error dominates the present educational policy of the Punjab.

It will be seen that there were in 1925-26 about 688,000 pupils, or seventy-six per cent of the total number, attending primary and middle schools. The increase in enrolment has been rapid, for in 1920-21 the pupils numbered only some 415,000. The above table requires explanation, for it would appear that the number of middle school pupils is not far short of the number at the primary schools. These unexpected figures are accounted for by the fact that many middle schools have primary classes, and the pupils (about three-fourths of the whole) attending such classes are shown as being in attendance at middle schools.

If one were to judge by the rate of increase in the enrolment of pupils in the last five years, it would appear that in five more years some eighty per cent of the boys of school-going age in the province might be attending school. Unfortunately, from this rapid increase in school attendance it cannot be assumed that after ten years or so the percentage of literate males in the Punjab would rise from 14, the present figure, to somewhere about 75, for by far the larger number of pupils who enrol in class I never become literate. Less than one-quarter of the boys who now enter class I continue at school until they have passed through class IV. Not all who pass through class IV remain literate, and very few of those who do not enter it can be expected to be able to read and write in later years.

Literacy in the masses, and not merely increased school attendance, is the aim which the Education Department has in view. In the furtherance of this object, attention is being concentrated on the training of teachers, the school curriculum, the formation of branch schools, the opening of vernacular middle schools in rural areas, the introduction of compulsory school attendance and the provision of schools for adults.

The teacher is the crux. It is recognised that for country schools teachers must be found "possessing sympathy and understanding of the village people." The most urgent need of the village is "a headmaster who will transform the village school into a village institution, will be respected by the village people and will be 'passing rich on £40 a year'" or on its

equivalent of Rs. 50 per mensem, which is what the Punjabi headmaster may expect to earn. Teachers' training institutions were outside the ambit of most village teachers; the device has, therefore, been adopted of attaching training units (a unit is a class of 40 students) to high schools and other suitable local institutions throughout the province. Of these units there are now 46 for junior and 12 for senior vernacular teachers. Ten years ago the numbers of teachers undergoing training were 796 and 82 respectively; they are now 1,840 and 480. Since the training centres are widely distributed, it is possible to secure many teachers from the agricultural classes. In recent years from 40 to 50 per cent of those under training were drawn from agricultural tribes, and not a few others had been brought up in rural surroundings.

In 1923 a special committee considered and reported on the curricula of vernacular schools. Their main conclusions were (1) that in primary schools "the subject matter taught and the methods of instruction pursued should be such as to bring the work . . . into the closest relation to the life and experience of the pupils . . . the acquisition of suitable knowledge and the attainment of literacy should be the main objects of the course; (2) in regard to middle schools, the central subject of study should be that of rural science, which should co-ordinate and vitalise many subjects already included in the curriculum." When this report was received, it appeared to be desirable that new courses should at once be framed, and suitable text-books prepared, but consideration showed that until teachers could be trained to interpret rural science to their pupils in the spirit and manner recommended by the committee, no substantial advance was possible. For the moment, therefore, there has been concentration on the teacher; in the meantime, by the establishment of new primary schools, by concentrating, where this is practicable, the teaching of classes I and II in branch schools, and by an important experiment in middle schools to which reference will presently be made, preparation is being made for the introduction of new and more educative courses in the rural schools of the Punjab.

This new policy will involve a very considerable increase in expenditure, and it is evident that if literacy cannot be secured, the expenditure must be wasteful. In the view of the educational authorities, the most effective way of avoiding waste would be compulsory school attendance up to at least the completion of class IV. But it is doubtful whether the province as a whole is yet ready for compulsory attendance. Without the backing of the community, especially of the parents, no Act decreeing compulsion could be enforced. The Education Department, therefore, place reliance on what they term "voluntary compulsion." The community must be educated to the point at which they will apply for compulsory education under an existing Act, and then it will be (as it already is in

a number of both urban and rural areas) a practicable measure to enforce compulsory attendance. The success of this policy may be gauged by the fact that in 1927, 1,600 rural areas had introduced compulsory education up to class IV. Moreover, the movement is widespread, for in 20 out of the 29 districts of the Punjab, at least one, and often many local bodies, had at that time voluntarily adopted compulsion. A specially interesting feature of the movement is that sometimes these local bodies take the form of co-operative societies of parents, who agree to send their children regularly to school; penalties against defaulters are in these cases imposed not by the courts but by the co-operative society.

Similar evidence of the public spirit which the co-operative movement has evoked in the Punjab is afforded by the adult schools, which are mainly, it is reported, the outcome of that enthusiasm for self-help which this movement has engendered. In March, 1926, there were 3,208 of such schools attended by nearly 85,400 adults.

Literacy, though acquired, is too often lost by the schoolboy, and the adult is exposed to a similar danger; as a counter to this evil village libraries are being provided. Following a lead recently given by Britain, the Education Department has set up a Rural Community Board, and district community councils, to supervise village library, adult school, local popular lectures and other general "uplift" movements. Where there has been concentration on the work of village uplift, astonishing progress has been made, as will be seen by the evidence given on the Gurgaon district.

From the agricultural point of view the chief interest in the educational position of the Punjab centres in the experiment now being made in teaching agriculture in middle vernacular schools. The growth of the middle vernacular school is one of the best tests of progress which can be applied to rural education, and it may be noted that since 1921 the number of lower middle schools, teaching only in the vernacular, has risen from 400 to over 1,340. It is recognised that the best chance of educating the most intelligent among those sons of the zamindar who will certainly return to the land is to be found in such schools; for once the boy learns English, there is a danger (and the abler he is the greater the danger) that he will seek his fortune in towns. It was decided, therefore, in 1919 to initiate an experiment in the teaching of agriculture in the middle vernacular schools. This experiment has now been working for seven years; the Punjab Education Department believe that it is on the right lines, and the methods employed are now being carefully studied by other Indian provinces; it will, therefore, be desirable to give some details. The reasons for the experiment, and the methods employed are given in a memorandum

issued by the Education Department in September, 1923; they are as follows :—

(i) It was decided to include, and to provide for, teaching in agriculture in the ordinary vernacular schools rather than to start separate agricultural schools of a special type. There are many cogent reasons in support of this decision. In the first place, separate agricultural schools are very expensive. In the second place, specialised training for boys below the age of seventeen is premature. And, above all, a sound and suitable measure of general education should be the basis of all specialised and vocational training. The aim of the Punjab Government is therefore to enrich the middle school course in rural areas by the inclusion of agricultural training and thus to bring it more in keeping with the environment of the pupils; and the object is to use agriculture as a means of mental discipline and training and as an important accessory to the general subjects taught in those schools.

(ii) The training is of a practical as well as of a theoretical nature. For the fulfilment of this object, farms of about three acres each are attached to those schools, in which this form of training is imparted. In 1923, owing to the financial stringency which then prevailed, an alternative was adopted in the form of miniature farms or school gardens. With the exception of a *beldar*, who looks after the bullocks, all the work of the farms is done by the boys.

(iii) The teaching is in the hands of trained and carefully selected teachers who have first taken the ordinary senior vernacular training course and have then completed a special course in agriculture at the Agricultural College, Lyallpur. By this means the necessary co-operation between the departments of Agriculture and Education is promoted.

In 1926 the experiment was in progress in 66 schools, 27 of which had farms, and 38 gardens; and in the same year 32 teachers, holding the Senior Vernacular Teaching Certificate, were undergoing training at Lyallpur, so that the number of middle schools with agricultural classes will soon reach 100. There is now no question that the experiment has been successful; but there is some division of opinion as to whether, apart from expense, a 3-acre farm or a $\frac{1}{2}$ -acre garden should be attached to the schools. Some of the senior members of the Agricultural Department fear lest the practical management of the school farm may not commend itself to the critical cultivator. On the other hand, it is pointed out that, assuming it to be properly managed, there is no question that the farm is educationally better than the garden; and that in fact some of these school farms are so well conducted that already cultivators are going to the agricultural teachers for advice, or to purchase seed of improved crops. Again, it is clear that the question of

farm versus garden is bound up with the capacity of the teacher, but it may be noted that the Education Department which, in this matter, is directly responsible, is well satisfied with the results hitherto secured, and is hopeful that not only will the school courses prove of direct educational value to the boys of middle vernacular schools, but that many of the school farms may become centres to which the parents will come for practical hints on the management of land. Those who have long realised how well the work of the cultivator is adapted to furnish a subject that may be turned to the educational benefit of the growing boy, will note with special interest the experience now being gained in the Punjab.

And it is not only in the middle vernacular schools that experience is accumulating. Stimulated by the example of American Presbyterian Missionaries, who in their experimental school at Moga have used agriculture and other industries as a means of quickening and training the intelligence of their pupils, the Education Department has started two centres, largely in imitation of Moga, for training teachers. One of these at Ghakkar was an ordinary training centre; its scope has been extended to include practical training in the "matters which should promote the well-being and progress of the Indian village." The other is a school of rural economy at Gurgaon, for senior teachers who already hold certificates. In the ordinary examination for teachers' certificates it has been found that the Ghakkar students showed the best results. The conclusion drawn is that "the fuller and wider training is not only good in itself, but that it also improves the efficiency of the ordinary training for the teaching profession in its limited sense. Steps are now being taken to extend this new form of training to all training institutions."

10. CO-OPERATION.

The total expenditure on Co-operation in 1925-26 was only Rs.6½ lakhs, but the guess may be hazarded that it is the work which the Co-operative Department has done for the Punjab that has suggested the title. If it has not, it may at least be claimed that "beneficent" well describes this department's activities.

There are now nearly 17,000 co-operative societies in the Punjab, and the number is increasing rapidly. It is estimated that 4 per cent of the male population are members of the co-operative societies. Most important are the 14,300 credit societies, and it will be necessary to deal with their organisation and character in some detail; but before coming to them it will be desirable to catalogue the other activities of the co-operative movement, so that an indication of its scope may be obtained.

Chief among these other activities, because of the size and difficulty of the problem to be solved, and because of the novelty

of the method of solution, is the work of societies for the consolidation of holdings. Fragmentation of the land into tiny and utterly uneconomic plots is an evil to be found in every Indian province, and it is common in several European countries. Hitherto, with one European exception all those authorities who have attempted to consolidate holdings, have done so by Statute and regulation. In the Punjab the plan of dealing with fragmentation through voluntary and co-operative methods was conceived. Co-operative societies for the purpose were established, and already, although the movement is quite new, about 98,000 acres in 314 villages have been consolidated and re-allotted with the consent of the owners and without resort to compulsion. Consolidation has not only much reduced the cost of tillage; it has enabled new wells to be sunk, and it has removed the cause of much quarrelling and litigation over boundaries. For, in spite of village maps, the boundaries of these innumerable small plots were difficult to define, and his neighbour's landmarks are not always sacrosanct in the eyes of the Punjab peasant. Other indirect results of consolidation show how important is its influence. For example, an owner who found himself with 200 acres in a single block enclosed the whole with a thorn edge—and the reporter adds, "if this practice were to spread, the consequences to agriculture might be momentous." Another result was a complaint that as a result of consolidation a cattle pound had ceased to be remunerative. Cattle-trespass, it should be explained, is a curse to the Indian cultivator; but fines add to the incomes of district boards.

The success of land consolidation in the Punjab is due to the fact that cultivators know compulsion will not be used against them. A committee is set up to re-allot the land, and it is not until each cultivator has seen and agreed to accept the new area assigned to him that the society is registered. Natural conditions in the Punjab also favour the work. In those districts in which progress has been most rapid the land of the village does not vary much in quality.

Cattle-breeding and sheep-breeding societies have already been alluded to. Of these societies there are now 181 with about 2,600 members. Livestock insurance societies were started, but they were not a success and have been closed; the premiums required to cover the risks were high, and greater than members were willing to continue paying.

Milk-recording societies were formed for the first time in 1926, and a special staff of recorders has been trained for carrying on the work required and promoting extensions. Progress is hindered by the superstition that milk-measuring is ill-omened; but when the societies increase beyond the present number of 23 it may be hoped that the fear of ill-luck will disappear.

Ninety-nine better farming societies are now at work; the members pledge themselves to follow methods recommended by the Agricultural Department. A member who farms badly may

be fined. Some of these societies hold agencies for seed and implements. A group of 26 societies with 432 members has been formed in the west of the province for the purpose of clearing the channels by which water is brought from inundation canals to their villages.

Five societies have been formed for cultivating land co-operatively, and the latest report is that they are "improving." But even in the co-operative atmosphere of the Punjab, co-operation for the tillage of land is beset with difficulty, and we read, "Quarrels have for the moment disappeared." The Assistant Registrar supervising them significantly remarks, "the members have realised their privileges rather than their responsibilities."

In every direction attempts have been made to organise agriculturists for better production, but success cannot yet be recorded in the case of fodder storage societies, poultry-breeding societies and one or two other efforts. Valuable experience is being gained of the purposes for which producers will, and will not, combine; but the co-operative movement in the Punjab has only just reached its majority (it started in 1905) and there is still hope the "will-nots" of to-day may become the "wills" of to-morrow.

Co-operation for sale has been begun. Thirteen commission shops were at work in 1925-26. Eight of these shops are in the Chenab Canal area, and in 1925-26 they sold produce to the value of Rs.21 lakhs. Of this form of co-operation the Punjab Administration Report, 1924-25, says: "Advocates of co-operation as the reliable panacea for all rural ills, write of co-operative sale of cultivators' produce as a simple, natural thing which has only to be mentioned to be adopted. In fact, few things are more difficult. In most countries, the middleman holds a strong position with well-established interests; and the Punjab is no exception." It is clear from this statement that the need for caution in developing effective sale societies in the Punjab exists, and is appreciated.

Co-operative purchase of seed, implements and other farming requisites, where this has been organised, is carried on through the credit societies and not by separate purchase societies. Such special purchase societies were formed during the War, to check profiteering; but after the War it was found to be undesirable to continue them.

Outside the ranks of agriculturists themselves, co-operation has been of use to village artisans. There are about 3,700 members belonging to 188 artisans' societies for assisting production, chiefly among hand-loom weavers and dyers. Rural artisans are eligible for membership of the ordinary village credit societies, and often take a leading part in their management.

Agriculturists, with other members of the village community, also form societies for such purposes as promoting thrift, for which there are 745 societies; or for compulsory education which gives work to 158 societies with 6,900 members.

Co-operative credit forms by far the most important feature of the co-operative movement, and its success in the Punjab requires that a description of the policy and methods that have led to results on so great a scale should be given.

In the section of this Introduction which dealt with the cultivator, reference was made to the huge volume of the Punjab zamindar's debt. Mr. Darling has estimated that in 1922 it amounted to some Rs.75 crores or £50,000,000, that the obligations of each debtor averaged Rs.468, that 83 per cent of all landowners were in debt, that tenants, like owners, were deeply involved and that the total agricultural debt of the province was about Rs.90 crores.

In 1905 when the co-operative movement began, agriculturists held *taccavi* advances of Rs.20 lakhs from Government under the Land Improvement Loans Act and the Agriculturists' Loans Act. On the average of the five-year period ending in 1924, such loans amounted to Rs.36.25 lakhs. These *taccavi* advances are made for productive purposes and they are specially useful in time of stress. In relation to the total volume of debt their sum is trivial. Outside the co-operative credit society, therefore, the cultivator has to look to private sources for the money he borrows. These sources are the village shopkeeper or *bania* who subsequently buys his produce and sells to him what he requires on lender's terms; the cattle dealer, from whom if he borrows he must accept the bullocks offered to him, on the vendor's terms; the commission agent who advances money on the growing crop, and is not always careful to pay market price on the crop when delivered; the goldsmith who makes advances on his jewellery; and his more prosperous neighbour agriculturist who takes a usufructory mortgage and so amply recoups his loan. It is impossible to say what the average rate of interest amounts to. It has been estimated, as already stated, at not less than twenty-five per cent. Looking to the general character of his creditors, it may not be unsafe to assume that once he has become deeply involved, the zamindar's creditor takes from him all he can give up. Thus the rate of interest will vary with the harvests; in a period of good years, the moneylender, not the producer, will reap the profits of bumper crops; in a series of bad years the return to the lender may not average more than twelve or fifteen per cent which he himself states to be his rate. There may not be an exact Urdu equivalent for the British maxim, but the Punjabi moneylender, in plucking it bare, is doubtless careful not to kill the goose that lays the golden egg.

It was primarily to deal with this evil, the stripping of a frugal, hard-working but simple and improvident peasantry of all its possessions, by rapacious moneylenders, that the Punjab adopted in 1904 the Co-operative Credit Societies Act. The new movement began in 1905 when a staff to foster it was created. This staff now consists of a Registrar who is a member of the

Indian Civil Service, assisted by two deputy registrars, and seventeen assistant registrars, all gazetted officers of the Provincial Service, one hundred and nine inspectors, fifteen sub-inspectors for artisans' societies, and eighty-five sub-inspectors for consolidation of holdings work.

Most of the sub-inspectors employed in the co-operative movement have matriculated, and all the inspectors (except some men promoted for meritorious work) are graduates. Preference is given to graduates in economics, and, so far as possible, all those employed in the co-operative movement are selected from among the rural community. In any case, all graduates selected are given one year's special training in the field and a three-months' course of study in rural economics before taking up the work of an inspector.

Above the inspectors come assistant registrars, each of whom will have 6 to 8 inspectors working under him, so that he may be dealing with from one to two thousand societies. The assistant registrars are appointed from among those inspectors who have had eight to ten years' experience. Finally, under the Registrar and in charge of all details of work, are two deputies, who divide the province between them. In time it is proposed to have a deputy registrar for each of the five divisions of the province, and also to extend the junior staff, so that each of the 29 districts may have an assistant-registrar and each of the 115 *tahsils* of the province an inspector.

These government officers are almost wholly employed in supervision and inspection, the policy of the department being that the business affairs of societies should be managed by themselves. The ruling body in the movement is the Punjab Co-operative Union, which conducts audits and carries on propaganda. It employs some 450 sub-inspectors. The union is managed by a committee set up by central co-operative banks and banking unions, and these in turn are controlled by the primary societies. The whole credit structure rests on a democratic basis. The broad, and broadening, base of the co-operative pyramid which has been built up in the Punjab is at present formed by some 14,300 societies; the apex is the Co-operative Union, while near-by, forming no integral part of the pyramid but essential to its setting, is the watchful Sphinx—the Registrar of Co-operative Societies.

The union's sub-inspector spends most of his time in auditing, but he must also help weak societies to improve their methods and he must never forget propaganda. There may be as many as six working in a *tahsil*, and each may have 50 societies to supervise. The government inspector may have as many as 300 societies in his area; he checks the work of sub-inspectors and organises new societies where these present special features.

At present there are, as already stated, some 14,300 primary credit societies in the Punjab. Their sphere is not, in all cases,

restricted to credit, but purchasing and other activities are limited. The membership of these societies is 407,500, and they are to be found in about 13,000 out of the 33,000 villages of the province. The capital employed in the credit societies is 11 crores, of which some 5 crores are in the hands of primary societies themselves. This sum includes Rs.68 lakhs in shares, over Rs.122 lakhs of reserves and undistributed profits, about Rs.48 lakhs in deposits, and Rs.2 crores borrowed from central banks.

Above the primary societies there are 116 central banks and banking unions whose funds are derived chiefly from the general public in the form of deposits. The resources of the central banks include Rs.46 lakhs share capital and reserve, Rs.37 lakhs deposited by primary societies and Rs.360 lakhs deposited by the public. The sums held from Government are small, less than Rs.5 lakhs.

In 1924 there was established a Provincial Co-operative Bank to function as a central bank for central banks. It is anticipated that it will take a leading place in co-operative finance. With the aid of a guarantee of interest for a term of years by Government, it is now issuing debentures in order that the mortgage banks referred to below may be assisted to increase their operations; debentures for Rs.5 lakhs have already been issued and subscribed by the public, and a total issue of Rs.20 lakhs is contemplated.

The primary credit society has an average membership of 26 persons, who may all belong to one tribe or caste; but as most villages contain one society only, a distinction of persons is discountenanced, and high-, low- or no-caste members are admitted. Essentially the primary society's success is bound up with the degree of mutual understanding and appreciation shown by its peasant members; just as its only outward and visible sign of existence "consists of a bundle of books tied up in a cloth," for the society has no office, nor telephone, nor telegraphic address. No stranger ignorant of the work that has been done for co-operation in the Punjab would suppose that this unadvertised village body was a unit in a big business; any more than, if ignorant of the canal system, he would connect some little rill of water in the neighbouring field with the Jhelum or Chenab 100 miles away. Those responsible for guiding co-operation in the Punjab have studied co-operative movements in many countries and have noted that too often they were swamped by over-much official management or over-much benevolent attention on the part of rural reformers. These errors they have avoided.

The books of the primary society are usually written up by an honorary secretary of little education, but he does his best, and the sub-inspector corrects the errors. If special difficulties occur an inspector may be called in. It is seldom that the affairs of these societies go far astray; and though the business is transacted by committees, few of whose members can read

or write, the rural population is gaining so much confidence in their work that everywhere there is a keen demand for the formation of new societies.

Primary credit societies differ widely in capacity and in the amount of attention which they require from the inspecting staff. They are classified into four groups. Group A, which, in 1925-26, included 4.25 per cent of the total, consists of those thoroughly competent societies which require no assistance from either the department's or the co-operative union's staff. Their accounts are audited, otherwise they are left to themselves. In class B come 26.25 per cent of the societies. These must be qualified to keep their own accounts, collect dues owing, prepare crop-demands, loan applications and arbitration references, and they must be able to enforce awards against defaulters. They may look to the inspecting staff only for advice and assistance of a general kind. When societies require help from the inspecting staff in the preparation of accounts, or for any of the business mentioned above, they are placed in class C. This is the most numerous type, accounting for 62 per cent of the total. In class D are placed the weakest societies requiring close attention by the inspecting staff; 7.5 per cent were so classed in 1925-26. So far 9,506 of the societies have been classified as above. the others await classification.

In order to ascertain the purposes for which the societies grant loans each sub-inspector analyses the loans made by five societies under his charge. In 1925-26 the affairs of 1,200 societies were thus investigated. The total of the loans granted was found to be Rs.35 lakhs. These loans were then classified under no fewer than 23 headings. The most important items for which money was borrowed were: cattle, 20.5 per cent; debt repayment, 26.0; trade, 8.5; ceremonies, 7.0; building, 4.0, and land purchase, 9.5 per cent. The last item was unusually high in 1925-26 because of the auction of land on new canals; in the preceding five years it had averaged 3.75 per cent.

The assets of all credit societies in 1925-26 amounted to Rs.162.87 lakhs, made up of shares Rs.58.52, reserves Rs.87.49 and profits Rs.16.86 lakhs.

The loans made by primary societies are usually for short periods not exceeding three years; but they may be, and frequently are, renewed. Repayment in 1925-26 amounted to Rs.150.38 lakhs, or 33.5 per cent of the sum on loan at the beginning of the year; about three-fourths of this total consisted of repayment of principal.

Primary societies usually borrow from central banks, or banking unions, the funds which they require at 8 to 9 per cent interest, and lend out to members at 12½ per cent. Many societies have accumulated a reserve which allows them to lend at lower rates of interest; in a few cases as little as 6 per cent is charged, and 9 per cent is a not uncommon rate. The Muslim religion discourages the taking of interest, and to

meet the views of the majority some thirty Mussulman societies, having accumulated funds, now lend to members without charging interest.

A central bank usually has its offices in the headquarters town of a district and the deputy commissioner often acts as its president; but his participation in the affairs of the bank is seldom more than nominal. The bank is formed by individual shareholders or societies. It has affiliated to it a number of primary societies, not all of which need borrow from the banks; all of them however, have a share in the management. The individual shareholders and the representatives of affiliated societies, each exercising a single vote, elect directors at a General Meeting. It is usual to provide that for every 100 affiliated societies there should be at least one director representing societies on the board. The societies have now in all cases got a majority of votes at the General Meeting and in most cases on the Board of Directors; but since the individual shareholders, and the directors representing them, are frequently educated townsmen, they are able to exercise guidance and control to an extent out of proportion to their number. The directors appoint a secretary usually one of their own number and a lawyer. Under the secretary the larger banks employ a paid manager, but the usual salary, Rs.75, rising to Rs.150, suggests that no great degree of authority is delegated to him. The accounts of the larger banks are audited by professional accountants or trained auditors, the accounts of the smaller by the department's inspectors.

A banking union differs from a central bank in having no individual shareholders. Its membership consists of affiliated societies. These unions borrow from the public, from central banks, or from joint stock banks. They are of great educative value, affording to their members practical training in finance and banking and scope for useful work in supervising constituent societies.

The central banks and unions pay interest on deposits, the rates generally varying from 5 to $7\frac{1}{2}$ per cent with the term for which the deposit is made. They lend to one another at from 7 to $7\frac{1}{2}$ per cent, and to primary societies at 8-9 per cent. Central banks may pay dividends up to 10 per cent; 8 to 9 per cent is a frequent rate. They must, like primary societies, carry 25 per cent of the profits to reserve. Banking unions pay no dividends. The reserves of central banks and unions in 1925-26 amounted to about Rs.15 lakhs. These reserves are not deposited in a single regional bank as is sometimes done elsewhere, but are held by the institutions themselves, and invested. The investments are lodged with the Imperial Bank of India. A certain amount of fluid reserve is prescribed and must be maintained. While the Co-operative Department, through the inspectors, is careful to see that the bye-laws are observed, nothing is done which is likely to weaken the sense of responsibility of the bank's directors.

Reference has been made above to the large amount of Punjab land which has been mortgaged. Much has been mortgaged beyond hope of redemption; but there is still much that a thrifty owner may hope to redeem. A controlled mortgage system based on reasonable rates may be, moreover, of the greatest value to the agriculturist, whether he be a large land-owner or a peasant proprietor. The ordinary primary credit society is not intended to deal with mortgage business, which usually involves a loan for much more than the three-year period which primary societies take as their limit. For this reason, land mortgage banks have recently been started in the Punjab. There was no prospect of achieving progress by copying the very successful *Landschaften* of Germany, which issue bonds on mortgaged property, that are freely bought and sold by the public. The monied classes would not have been attracted by such securities, and the Punjab had to gain experience for itself. The first mortgage banks in the province were created to serve a district, and their funds came mainly from government loans granted through the Registrar. Experience has suggested that the district is too large an area to enable adequate supervision to be given, and after four district banks had been at work for a year or two, five new banks serving smaller areas, usually a tahsil, were founded. The first four banks were of the unlimited liability type, the others have adopted limited liability. To obtain an advance from one of them, a borrower, if there is a credit society in his locality, must belong to it, and must gain its support and guarantee for his loan up to a maximum of Rs.1,000. In other cases the mortgage banks satisfy themselves by accepting the security of the applicant's land, supplemented, if need be, by that of guarantors. As the newer banks work within a small area, the directors, who value the land, and may grant a loan up to fifteen times the value of the estimated annual net profits, keep in close touch with the borrower's affairs and the management of his holding. The usual rate of interest is nine per cent. The loans are granted for short periods. In contrast to European banks, where the period of loan may be 30-40 years, and repayment of principal is secured by a sinking fund, the Punjab banks grant loans for short terms, usually not more than fifteen years (in no case can they exceed twenty years) and repayment of principal is required in uniform periodical instalments. The 20-year period is governed by the terms of the Punjab Alienation of Land Act. For under the provisions of this Act a co-operative mortgage bank is not an "agriculturist"; it cannot, therefore, sell the land of a mortgagor, it can only take the annual income, and for a period not exceeding twenty years.

The first banks, being experimental in character, were chiefly dependent on government loans; experience now having been gained and successful working secured, the banks must look to the co-operative movement for funds, and in the second stage of

their work money is being found, as already stated, by debentures, which are being issued by the Provincial Co-operative Bank, aided by a government guarantee of interest. The conditions in the Punjab, and the position and experience gained by the eleven mortgage banks now working, suggest that this form of co-operative activity will develop rapidly. The volume of business as compared with that of the credit societies is, however, quite small at present. The working capital amounts to about Rs.13.5 lakhs, of which Rs.1 lakh consists of share money, and profits (no dividends are paid) and up to June, 1927, 16,000 acres of land, on which mortgages were held by moneylenders, had been redeemed by shareholders in the co-operative mortgage banks. Mortgage banks may, and do, assist other objects than the redemption of land in the hands of moneylenders. Members mortgage their land in order to effect agricultural improvements and they may also mortgage in order to pay off debt of a general kind.

11. COMMUNICATIONS AND MARKETING.

The rapid increase in the agricultural output of the Punjab in the past half century has out-run the progress made by its communications. A new programme of road development, which will be referred to later, was adopted in 1924, and recently there has been much discussion of tramways, motor transport and light railways as feeders to the main railway lines.

The province is served by the North Western Railway Company, which has some 6,800 miles of railroad under its charge between the Khyber Pass in the north and Karachi in the south. By far the greater part of the mileage is in the Punjab; and an examination of the map shows that fertile parts of the province are well served with railway lines. They traverse the plains, roughly, in a N.E.-S.W. direction at intervals of 20-40 miles in the canal colony area. Crossing these lines is the main line running N.W.-S.E. between Peshawar and Delhi through Lahore, with, to the east of it, a network of lines connecting up all important towns. In the west there is a line branching from the Peshawar-Delhi line near Rawalpindi in the north, traversing the Indus Valley to Muzaffargarh in the south and joining up with the other lines leading to Karachi near Bahawalpur.

The railway system is being extended on a programme which contemplates an addition of some 800 miles annually in the next five years. The present extensions are being constructed mainly in the interests of agriculture. The management of railways has not been transferred and rests with the Government of India; but in accordance with a policy adopted in 1924, a province may have the lines it desires if it is prepared to guarantee the Central Government against loss. Should the line be one, which, in the view of the Imperial Railway Board, is likely to be profitable, no guarantee is exacted. At the present time two lines, one of

5 feet 6 inches gauge and one of 2 feet 6 inches, are being constructed under a guarantee, and one 5-foot 6-inch line is being made without a guarantee.

There has been much discussion on the advisability of feeder tramways not under railway management. Advocates claim for these that they would be cheaper than roads, and that local management would ensure attention to local needs. On the other hand, it is pointed out that they would not admit of through booking, and that the charges which tramways would require to make in order to run at a profit would be likely to lead most cultivators to continue to do their own carting, so that little relief would be given to the roads. The present policy favours the construction of light feeder railways rather than tramways, but it is admitted that further experience may show tramways to be desirable for some districts.

Attention is also being given to motor transport. For passenger traffic the motor omnibus is spreading quickly, but for the conveyance of agricultural produce the motor van must await the development of metalled roads. For wheeled vehicles access to villages, except the few situated on the metalled roads, is barred by the condition of village lanes. The track or half-track vehicle is more likely to penetrate to villages than is the motor van, and experiments with it are desirable. It remains to be discovered whether in the present condition of village approaches, even the track vehicle could negotiate them with sufficient success to displace the indigenous means of transport.

There is much uncertainty as to the volume of the hired transport traffic in different parts of the province. It is known that in many districts hired carts and camels play a large part; but the cultivator does a great deal of carting to market, thus is it difficult to forecast the success of such alternative means of transport as motor traction or tramways.

There were in the Punjab in 1924 some 25,000 miles of road, excluding village lanes, but the condition of many of them was far from satisfactory, and in that year a new policy was framed. In the earlier years of the century the work of engineers on canals had far outstripped the work on roads; largely increased quantities of crops were being grown, and relatively little was being done to facilitate their movement to market. The Public Works Department, before 1924, had been responsible for some 1,800 miles of roads only, one-third of which—mainly in hill districts—were unmetalled. The remaining roads were in charge of district boards who had taken over responsibility for roads of different degrees of importance at various times. The chief roads in charge of the local authorities were those known as "Provincial Roads in charge of District Boards" and for these when taken over in 1911, earmarked grants for maintenance had been made. But these earmarked grants had gradually become merged in the general funds of the boards, and the pressure of other demands on local funds led to so much neglect of the roads

as to cause general complaints of their condition. The case for a new road policy was clear; a Communications Board was set up, and a new road programme drafted. This new programme has just been taken in hand, and its salient features may be indicated.

Punjab roads, as distinguished from village lanes, have now been grouped into three classes. Class I embraces arterial roads, and their construction and maintenance is entrusted to the Public Works Department. Excluding the Grand Trunk Road from Calcutta to the Khyber, which passes through the province, these arterial roads will mostly radiate from Lahore, will pass through all district headquarter towns and also traverse towns with a population exceeding 20,000. While maintaining the general arterial plan, branches will, where necessary, connect up important towns off the main routes. At present there are some 2,000 miles of metalled and 2,600 miles of unmetalled road in this class, and the policy is to metal all class I roads where heavy traffic makes this necessary. Because of the distance from which material must be brought, metalling is very expensive on the plains; the cost of annual upkeep is also high and may amount to Rs. 1,000—Rs.2,000 per mile. Class II, now known as "Main Roads," consist of roads of secondary importance maintained jointly from provincial and local revenues. They include roads passing through more than one district, or connecting up towns with 5,000 to 20,000 inhabitants. There are about 7,000 miles of such roads in the province, largely unmetalled. There remain some 13,000 miles of class III roads, almost wholly unmetalled, to be maintained by district boards out of their own funds.

At the present time, apart from the roads in the Nili Bar canal colony area, which are being financed out of the proceeds of land sales, the cost of roads to the Government is about Rs.35 lakhs for class I roads, and Rs.6 lakhs for grants-in-aid, of class II roads. It is estimated, if the present programme is carried out, that in fifteen years time the expenditure on roads from provincial revenue will be Rs.80 lakhs and from district board funds Rs.30 lakhs.

This great programme of extension is yet in the future, and as will be seen it aims mainly at supplying the pressing needs of the fertile plains. At the present time the Punjab offers contrasts in means of transport as great as can be found in any part of India.

The hill regions, the canal irrigated plains of the centre and the waterless plains of the west are of widely different importance from the point of view of agricultural transport; but each of them has its own transport problems, and each its own method of meeting them.

A few roads are maintained by the Public Works Department in the mountainous north, but in most of this region the limited

amount of transport called for presents much difficulty. Timber is floated down the rivers, but for other traffic pack animals, or coolies, are chiefly employed, and so great is the need, that sheep travelling from low-lying pastures to the hills may be used to carry packets of salt, or other small parcels of goods, on their backs.

Over the greater part of the plains the country cart, drawn usually by bullocks, sometimes by buffaloes, is the chief means of transport from the village to the market town. The horse is more often seen on Punjab roads than in other provinces, but with rare exceptions his load is a human one; he is not called upon to pull ordinary agricultural produce to market. The bullock carts are strongly built, as they need to be, but from the point of view of the road engineer their design is destructive, and efforts are being made to introduce wheels of a less damaging type. The peasant himself is not concerned with the effect of wheels on roads, but with their capacity to hold together on village lanes; the cart is to him a treasured possession; now and again a substantial zamindar who would think long before spending Rs.40 on a new iron plough, may be found in possession of a cart with highly decorative brass mountings, which has cost him Rs.400. It is well, perhaps, that his æsthetic sense should be gratified by contemplation of his cart, for the village lanes along which he passes could gratify no one. Unlike the wide hedge-lined lanes to be seen in some parts of India, they are usually narrow tracks, so narrow that carts pass each other with difficulty, they have thus been described to the Commission in the Punjab Government's memorandum:

"Years of wear and neglect have resulted in their becoming depressed below the surface of the surrounding fields, so that in irrigated lands they are perennially and in others periodically liable to inundation, when they are puddled by passing cattle and bullock carts into a dreadful morass, aggravated by the buffalo who in his frequent baths may soon wallow out a mud hole feet deep and yards across. The Communications Board has recently initiated a policy for the improvement of these lanes, but progress is slow. They appear to be 'no one's child,' no authority budgets for their maintenance, and even their ownership is in doubt."

In the arid western country on both sides of the Indus agricultural transport is reduced to a small problem by the fact, that there is little produce to carry. Roads and lanes alike are almost non-existent away from towns and railway stations. The chief transport animal is the camel, and he takes the "desert's pathless way." Until quite recently the camel was indeed a most important means of transport throughout the Punjab plains, but the coming of the canals, with their great new areas of wheat and cotton has altered the position. The loads of wheat and cotton are greater than his numbers can

cope with, and though the camel's back may still be unbroken, the heavily watered country is breaking up his constitution. The camel is disappearing from the canal colonies; but he is still so much a characteristic beast of burden in the Punjab, that here alone in British India his claim to recognition is officially admitted. It may indeed be hoped that, in gaily caparisoned teams, he may long be seen trotting across the parade ground, or along the racecourse, of Lahore, and that on great occasions, a camel carriage may remain an appropriate means of transport for Governors of the Punjab.

In an inquiry made into the cost of rural transport in the canal colony area in 1923, it was found that the camel was then still the cheapest means of moving wheat and cotton to market. The customary rates per maund per mile were found to be: for carting wheat long leads up to 20 miles, 3 pies, and cotton, 4 pies; for camel transport, wheat, 2 pies, cotton, 3 pies. Carting causes less trouble in loading and there is less risk of damage than in camel transport; thus, apart from the difficulty of securing enough camels, carting was found to be favoured in the majority of districts.

It will be seen that where the cultivator resorts to hired transport the cost is heavy. For a distance of 10 to 12 miles he may have to pay 3 annas per maund for wheat, which in the market town may fetch about Rs.4-8. A charge of about 6 annas would carry the same wheat from the centre of the Punjab to Karachi.

Apart from the possible introduction of cheaper forms of rural transport than the cart and camel or the improvement of roads, the chief means of reducing to the cultivator the cost of marketing agricultural produce is by providing local markets where few now exist, so that the lead to market may be reduced to one which the cultivator will negotiate with his own cart.

Inquiry suggests that markets, or *mandis* as they are termed in the Punjab, should exist at intervals of from 20 to 25 miles. If at this distance the lead is within the dimbit of the average cultivator and the area served would be large enough to attract a good attendance of buyers. Very small *mandis* are to be deprecated because of lack of competition.

Until recent times the cultivator sold practically all his produce to the village *bania*, to whom he usually owed money, and it was the *bania* who brought it to the market town and sold it to wholesale traders; but rapid changes are taking place, and though the village *bania* is still believed to be much the largest seller of village produce in *mandis*, cultivators, in increasing numbers, themselves cart wheat, cotton and rape seed to market and sell it there. For this desirable change there are many causes, the growth in the export trade, the work of the Agricultural Department in organizing sales of special products like Punjab-American cotton, the spread of education, and, most of all, the extension of the co-operative movement.

To further the good work thus begun, the Communications Board of the Punjab have kept the need for new, and well-spaced, *mandis* constantly in view in developing their road policy, and the hypothesis on which they now work is that "given good roads trade will flow easily to a *mandi* from within a 12-mile radius." On this assumption the needs of the Punjab cultivator for transport facilities have been surveyed and a map prepared showing the gaps in the *mandi* system which remain to be filled.

The importance of the *mandi* to the Punjab cultivator is very great. It is believed that 90 per cent. of the exported produce passes through these local markets. The Government is, therefore, further attempting to aid the marketing of agricultural produce by constructing model *mandis* in the colony areas. The lay-out of a modern local market town is as follows. The *mandi* serves 500 square miles of canal-irrigated land; it consists of a grain market, four or five cotton-ginning factories, a market for imported timber, iron and steel, and bazaars, with shops for supplying all the cultivators' wants. (Cotton goods, odibles of all sorts, brass and earthenware pots, tin-ware, petroleum stores, sewing machines and bicycles are the things that first catch the eye of the passer by in these market town bazaars). The grain market consists of a set of shops built round three or four sides of a rectangle; there is in front of them a wide brick pavement for unloading, displaying, weighing up and bagging grain. In front of the pavement is a wide metalled road enclosing an open space for parking carts. When the *mandi* is on the railway the grain market adjoins the station and it may even have a siding of its own.

Reviewing the position of marketing in the Punjab it may be said that facilities for the sale of wheat, cotton, rape seed and other exported field crops are good. The commodities now requiring and receiving further attention are fruit, vegetables, eggs, and light perishable produce generally. Except in the case of certain fruits there does not seem to be much export of this type of produce; it is bought and sold for local use. *Mandis* take a share of the trade, but much of it is done in the villages and on the volume of the business done, or the special needs of traders, not much information appears to exist.

Livestock in the province are generally sold at local fairs, which are held at stated times in many places. The fairs, which may combine some of the elements of an agricultural show with those of a market, are attended by the general public, as well as by itinerant herdsmen, shepherds and cultivators, and they may continue for a week. The Agricultural Department use these fairs for staging exhibits of their work, and demonstrating new implements in operation: and sports such as racing, and tent-pegging may be held to add to their attractions. The fair is, therefore, an important rural event. But except for the passenger traffic it makes small demands on transport, for the livestock of the Punjab are almost all of a kind that walks to market.

12. LOCAL SELF-GOVERNMENT.

The form of Central Government in the Punjab follows that in other Indian provinces of British India; it is well known and need not be referred to here, but it will be desirable to indicate the character and work of district boards and village panchayats; for their activities bear very closely on education, sanitation and other subjects affecting rural welfare.

For each of the twenty-nine districts of the Punjab, a district board was created by the Punjab District Boards Act, 1883, and by Statute certain duties were laid upon the boards. The Act provided for the imposition of further duties by direction of the Central Government, and, as the district boards gained experience, a number of matters were placed under their jurisdiction. The range of their functions is now very wide, and under their control are subjects as diverse as the management of public property and the registration of births, marriages and deaths; the construction and repair of public roads and the provision and management of hospitals, schools and markets; the supply of drinking water and the reclamation of soil; the planting of trees and the improvement of livestock; the provision of demonstration farms and the disposal of mad dogs. In some instances particular duties have been allotted to certain of the district boards, for example, the posting of Bombay cotton prices in the market-place of an important cotton tract, the purchase and sale of pure wheat-seed, and the management of a racecourse in a horse-breeding locality. At first the deputy-commissioner of the district was appointed chairman, and in nearly all cases he still occupies this position; but the policy is to make the boards non-official, and recently boards were informed that, in those districts in which three-fourths of all the members were elected by popular vote, permission will be given to Boards under certain conditions to elect a non-official chairman. At first little interest was taken in district board elections, but their functions bear on so many subjects of popular concern, that the position has changed, and it is noted that in one of the two districts in which elections were held in 1925-26, 32 out of 34 seats were contested, "great interest was excited" and "in several cases there was rowdyism at the polls." There is a prescribed minimum number of meetings, but three boards only in 1925-26 held the minimum number; most of them meet monthly, and, as in the case of British county councils, important subjects are referred to committees.

The income of district boards in 1925-26 was Rs. 100 lakhs of which 57.3 lakhs come from local rates and government grants (under the headings education 53 lakhs, medical relief 2.3 lakhs, and civil works 22.6 lakhs) amounted to 77.9 lakhs; the balance came from such sources as school fees, profits on canals, pounds, fairs, ferries and arboriculture, and special taxes,

such as the profession tax. The expenditure of district boards in 1925-26 was about 184 lakhs, of which about 50 per cent was on education, 12.5 per cent on medical relief and public health, and 19 per cent on roads and other district works, excluding medical and educational buildings.

A second local authority concerned with matters affecting the welfare of the rural population is the village panchayats. An Act establishing panchayats came into force in March, 1922, and in 1926 there were three hundred of them in existence. Panchayats are required to undertake the improvement and maintenance of public ways, drains, the construction and repair of wells and tanks for the supply of drinking and bathing water, and the provision of burying or burning grounds. Other duties may fall to them; if called upon they must act as school committees, and they may undertake poor relief, tree planting, the improvement of village livestock, the promotion of cottage industries, the maintenance of libraries and the prevention of nuisances. They are further empowered to exercise "local option" in respect of drink or drug shops, and they may be called upon to try petty criminal and civil cases. Under this last function some 1,170 criminal and 5,290 civil cases were disposed of in 1925-26. The average sum decreed in civil cases was Rs.20-10. It is noted by the Punjab Government that on the whole the judicial work was well done and that it appears to have been appreciated by villagers. In view of the ryot's love for litigation a cheap and expeditious method of gratifying his instincts is useful, and though no more than a beginning has yet been made, it would appear that the village panchayat had in front of it a wide field of social service.

13.—PUBLIC HEALTH AND SANITATION.

Taking the province as a whole, it may be stated that the Punjab peasant is the sturdiest and best-fed specimen of his kind among those who now till the plains of India; but in recent years, at least, he has reached the unenviable position of showing a higher rate of mortality than do the inhabitants of any other province. This fact is accounted for by the liability of the Punjab to suffer from epidemics. The influenza epidemic of 1918, which the Director of Public Health refers to as the "greatest epidemic tragedy in human history," is estimated to have produced a death-rate of 51 per 1,000 in the rural areas of the Punjab; an epidemic of plague in 1924 killed 250,000 people; ten years earlier there had been another severe epidemic of plague and in 1908 there was a great outbreak of epidemic malaria. Those who have attempted to account for these epidemics have shown that a number of factors are involved; some of them common to Indian peasantry, e.g., the defenceless condition of villages, unprotected by sanitary safeguards when epidemics start; others special to the province. These special conditions do not seem to be closely connected

with the soil, or to be related directly to the recent spread of irrigation. To account for them one must literally look to the air, i.e., the predominating factors are meteorological. It is now claimed that from the rainfall of July and August it is now possible to predict with fair accuracy what the mortality from malaria will be in certain districts; and the temperature and atmospheric humidity of the months January to May are controlling factors in the spread of plague. The heavy death-rate from plague in 1924, for example, followed on a high rainfall in January and February, and abnormally cold humid weather from March to May. The epidemic was checked as soon as the weather became hot and the air dry.

In order to effect improvement in the sanitary conditions of the province, the old Sanitary Department was reorganised as a Public Health Department in 1920; and, as will be seen from the evidence of the Director, this department insist strongly on the maxim that prevention is better than cure.

The department aim at providing a medical officer of health and a sanitary inspector in each Punjab district, and in 1926 several medical officers and sanitary inspectors had already been appointed. As a reserve for dealing with epidemics throughout the province twelve epidemiologists have been appointed, and three others, with the assistance of a chemist, are engaged in laboratory studies.

The staff of the Public Health Department work in close co-operation with other departments. For propaganda the village schoolmaster is enlisted. The Rural Sanitary Board (under the Ministry of Agriculture) whose work has been referred to in connection with land drainage, is one of the department's best auxiliaries; and the engineering staff employed in sanitation, which has been increased, are in consultation with public health officers now doing much to improve water supplies. At the present time district boards are expected to take the initiative in improving water supplies and sanitation in villages; but owing to the large areas under their supervision, villages are apt to be neglected.

The Public Health Department maintain a Vaccine Institute and supply lymph for inoculation against smallpox to the vaccinators employed by local bodies throughout the province. They further maintain a staff of vaccinators who are employed in work in some of the smaller Indian States, thus incidentally protecting British districts from infection. The value of vaccination is everywhere understood, except in some small Hill States where apathy is due to ignorance. The conscientious objector is unknown in the Punjab. On the other hand, there is carelessness, as in all countries, and re-vaccination, especially of females, raises difficulties. Constant propaganda and effort are, therefore, required. At first inoculation against plague was unpopular, but the value of the protection given is now recognised and inoculation is sought for by villagers when outbreaks occur.

Some of the investigations on which the Public Health Laboratory workers are engaged are of special agricultural interest. For example, the question of the relation of malaria to rice cultivation has recently been studied. The tentative conclusion was arrived at "that rice cultivation appears to be in some measures conducive to endemic malaria." On the other hand, surveys made near towns have shown that there is no correlation between rice-growing and spleen rate. "It may, therefore, be inferred that conditions favourable to endemic malaria result not so much from the cultivation of rice itself as from the circumstances associated therewith. . . . The conclusion is in fact irresistible, that many factors are concerned in the mechanism of endemic malaria and that the anopheline (mosquito) factor, although an important and essential factor, is incapable, in the absence of other essential factors, of determining the incidence of endemic malaria."*

The conclusion at which the Public Health Department arrive in placing an account of their activities before the Commission is indisputable; it is "if the Punjab agriculturist is to reap lasting contentment and benefit from improved methods of agriculture, the existing lack of protection from the incidence of disease will have to be considered along with improvements in regard to agriculture."

* Punjab Administration Report, 1924-25, p. 59.

